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PALLAVA BAGLA & BIMAN BASU

Building roads on the desolate borders of India is a task which puts both man and machine to its ultimate test



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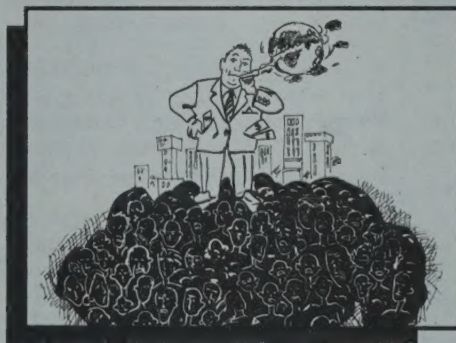
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C. B. Sharma

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A. S. K. V. S. Sharma

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SALES & DISTRIBUTION OFFICERS

L. K. Chopra

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ART

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Phones:

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Production: 573-0147 Sales: 578-5359

Fax: 573-1353 Telex: 031-77271 PID IN

E. Mail: pid@sirnetd.ernet.in

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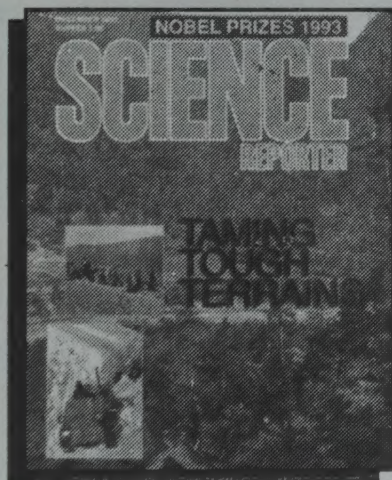
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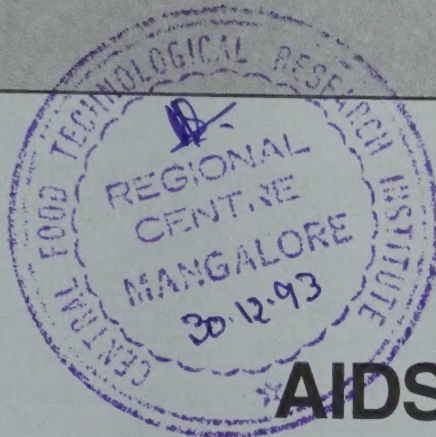


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In Focus

AIDS Awareness

Within less than a decade since it was first identified in US homosexuals, AIDS has today become the biggest scourge of mankind threatening, may be, its very survival. Since the virus that causes it destroys the very defence system that protects humans from infective agents, and there is no effective drug yet available against it, the hapless victim is only left to die a slow and agonizing death.

Despite optimism in some quarters, a vaccine that can prevent infection by the virus still appears a distant dream as the failure of recent trials of a candidate vaccine in Europe and the US indicate. What is more alarming is the prognosis by some experts that by the turn of the century poorer countries like India may be harbouring the largest number of AIDS patients in the world. The only way to make it not happen is, ironically, by preventing the spread of the virus in the first instance. Since the virus spreads only through blood or blood products or sexual contact, simple precautions like use of condoms and screening of blood before transfusion could adequately check its transmission.

Unfortunately, it is easier said than done. One of the major hurdles that comes in the way of the success of even such simple measures is the widespread ignorance among the populace about AIDS. Unless people are made conscious of the grave risk they are exposed to they may not willingly accept the preventive measures.

At the same time there is also urgent need to make people aware of the various misconceptions about AIDS, that still prevail and make the life of AIDS patients insufferable. Even hospitals have been known to refuse to treat HIV positive patients.

It is time such unfounded fear is removed from the minds of the people. Be it the risk of getting it or the absence of it, the public at large still remain ignorant about matters concerning AIDS. The only way out of this imbroglio is through a concerted mass awareness drive not only through the mass media but also by involving the various social action groups. As of now, in matter of AIDS awareness is the key to prevention.

Reactions

Take Heart

Accept my heart-felt congratulations for your interesting, informative and illuminating editorial **Learning by Failure** (SR, October 1993). In fact, victory is highly uncertain but not impossible. Often we find that there is victory in our defeat. Our space scientists should not lose heart and confidence due to their failure. They should remember that there can be no better way of learning than from our past failures.

Haladhar Barik
Keonjhar (Orissa)

Ringin True

This refers to your September issue with the cover story on C-DOT'S new electronic exchanges. I would like to share my joy with your editorial team and the engineers and technicians of India's telecom department. In February 1992 telephone poles for the new exchanges were being erected in my village Nehra in district Darbhanga (Bihar). At that time no one gave it a second thought as it was treated like any other government job, of money being spent and nothing materialising or white elephants being created. But lo and behold! Come June 1993 and the exchange of 100 lines was inaugurated. One could dial any place in India within seconds. One could even make international calls! It was simply too good to be true for something like this to happen in a relatively backward state like Bihar. Indeed this gives a new meaning to the term

"global village".

Rohit Choudhary
Bihar

Wild Connection

Thanks to Bipul Chakrabarty for his article **Tuning In To The Wild** which appeared in the October issue of SR.

The article indeed provided a lot of information on radiotracking. I understand, radiotracking is a very promising method of studying the behaviour of wild animals. Save for a few handicaps it is very useful. It can be expected that the advancement of physical science and technology will soon overcome these barriers.

Biplob Borthakur
Jorhat (Assam)

Present the Past!

Our dear magazine SR will soon be completing 30 years of publication and I would like to put forward my humble suggestion which would, perhaps, add one more feather to its cap. Sir, many interesting articles published in this magazine during this period would have raised applause from all over. Many young and enthusiastic readers like me could not go through such articles. I suggest and request you to please start a new column titled PAGES FROM THE PAST in which you may publish excerpts of such interesting articles published in this magazine in the past.

This will really benefit many young readers.

Saif M. Hussain
Calcutta (W.B.)

Dubious Discoveries

The article **Solar Control of the Atmosphere** (SR, October 1993), which has been reprinted from *Science and Culture*, was interesting as one gets a glimpse of the progress of science and the prowess of Meghnad Saha in a different field.

It has been mentioned that the spectrum of aurora contains a green line which was erroneously attributed to the hypothetical, lighter than hydrogen, 'geocoronium'. It seems spectral lines have an uncanny way of confusing and confounding the scientists because fanciful names such as 'voronium', 'nebulium' and so on were coined to denote newly discovered elements, but their creators eventually had to face disappointment and ridicule.

Overexuberant excitement concerning a discovery can perhaps lead to unpleasant consequences. The supposed discovery of 'N-Rays' in 1903 by a French physicist proves that discretion is the better part of valour.

One can recall the case of the famous astronomer Percival Lowell, who proposed the existence of the 'Martian Canals', but his views were not shared by competent observers, who tried to observe his findings.

The discovery of a new form of water called 'polywater' created a lot of flutter. Its chemical and physical properties were also given. However, later on chemists washed their hands off it.

A few decades ago a very effective contraceptive having the formula $(NO)_6$ and

possessing a benzene like structure, with C and H being replaced by N and O, respectively was announced. This news elicited serious enquiries but it was soon realized that someone was enjoying a joke at their expense.

Then there is also the example of the claim of a French astronomer, about a century ago, regarding the existence of a planet 'Vulcan', between Sun and Mercury. The new cosmic body, however, failed to become a member of the solar system. In this connection, reference can perhaps be made of the planet 'Aster' or 'Phaeton' which is believed to have disintegrated to form the asteroid belt between Mars and Jupiter.

S.K. Gurtu
Delhi

More on Scientists

The **Swadeshi Scientist — Meghnad Saha** by V.G. Kulkarni (SR, October 1993) was full of inspiration and interesting information. Though not born with a silver spoon in his mouth Saha did indeed make a mark in the history of science. I request you to give such information on other scientists too.

B. Srinivasan
Kothagundam (A.P.)

II

I have read with great interest the two well written articles on the eminent scientist, Meghnad Saha, published in the October 1993 issue of your magazine. I would like to add some more points.

Reactions

Professor Saha's teacher, late Professor Prabodh Chandra Sen Gupta, had influenced him in Astronomy, from his college days. So, Saha had a special fascination for Astronomy, in which field, he later made outstanding contributions. He may be called the Father of Astrophysics in India. Starting from the work of Galileo, if ten important discoveries are listed, then Saha's contribution will be in that list.

M.N. Saha received a grant from the Tatas for establishing a nuclear research laboratory and for erecting a cyclotron. B.D. Nag Chaudhury was entrusted with the job. This

was the beginning of nuclear research in Calcutta which led to the foundation of the Institute of Nuclear Physics (later named as the Saha Institute of Nuclear Physics).

M.N. Saha participated quite actively in the establishment of the River Research Institute under the Government of Bengal. Saha also wrote a text-book entitled a *Treatise on Heat* along with his student B.N. Srivastava. It ran into several editions and was of international standard.

Saha was a great nationalist. He was highly depressed at the partition of Bengal. He saw the plight of the refugees from East Bengal and took up their

cause along with other prominent leaders like Syama Prasad Mookerjee.

After the sudden death of Syama Prasad Mookerjee in a prison in Kashmir in the year 1953, a big void was felt. Saha sought for election to the Lok Sabha and was duly elected. Saha at that time was suffering from hypertension. Besides he had to look after the administration of the Indian Association for the Cultivation of Science as well as development of the Institute of Nuclear Physics. The strain was too much for him. He passed away in Delhi in 1956, on the roadside on his way to attend the Lok Sabha. This appears like a Greek Tragedy.

Both M.N. Saha and his first son Ajit Kumar Saha

became Presidents of the Indian Science Congress Association. This is a singular incident in the history of Science Congress, where both father and son held the same portfolio.

N.K. Maitra
Pondicherry

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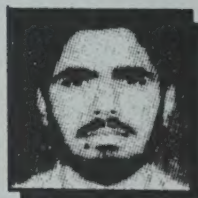
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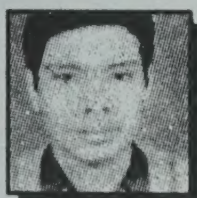
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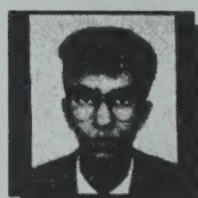
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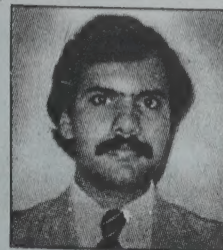
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• I topped the DAV College Chandigarh. I increased my reading speed from 303 to 1000 words.

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— Prof M Bhatnagar, PhD, Formerly in USA

• It is lucid, simple, powerful.

— Prof I J Nagrath, Deputy Director, BITS Pilani

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Research shows that without revision, in 24 hours

Can You Answer These Questions

- For better memory, should you study early in morning or late in night?
- For better memory, should you read fast or slow?
- Do examiners give more marks if you write more and fill more pages?
- Which vitamins can help your brain function better and improve your IQ?
- Should you study continuously or take rest?
- Why does eating before an exam reduces IQ?

For such questions, please read this page fully.

we forget 82%. So, we remember only 18%.

As time passes without revision, we remember less and less. After one month we remember about 5%. Most people attend classes or make notes, but they do not revise enough, so they do not remember as much as they can, and their hard work is wasted.

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 - Systematic Revision and Deafly Routine: The easiest and most powerful memory techniques • 4 more topics
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BIO-DATA

- B E, BITS Pilani. M Tech, IIT Kgp. NTS scholar. Rank 5 Raj High School Board.
- The maximum the USA companies paid for me in a single month was \$18,002 (over Rs 5 lakhs in one month). At peak of success, I left USA to return to India to teach my mind power study techniques. Now I spend my full time to research Mind Power in India.
- World-famous author. Published 3 books in USA including my best selling book "Tricks of MS-DOS Masters", 721 pages, \$27.95.
- Increased my reading speed from 72 words to as fast as 1037 words per minute.
- My first job as an engineer paid only Rs 1000 per month. Finally, I earned \$50 (Rs 1500) per hour in USA as a computer expert.
- Expert in computers, mind power, study techniques. Spent \$1300 (about Rs 40,000) for 2 seminars in USA to learn the mind power techniques called Neuro-Linguistic Programming. Was a member of Society for Accelerated Learning & Teaching, USA.

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Cover Story

TAMING TOUHG TERRAINS

Building roads in the hot desert, thick forests or snow bound mountains is not an easy task.
PALLAVA BAGLA and **BIMAN BASU** explore the challenges builders of roads in these inhospitable terrains have to face and how they cope with them

THE mid-April sun was beating down mercilessly and we were in the middle of the desert in western Rajasthan. The road on which we travelled from Jaisalmer in our Gypsy suddenly appeared to vanish into a sand dune shortly after we crossed the town of Longewala. Men and women with shovels were already busy clearing the sand from the road. It took some hours before we could resume our journey.

Two thousand kilometers away, at the other end of the country, it was a different story. The road we took from the town of Doomdooma in Assam went under turbulent waters of the Noahding river then in spate. It took quite some time, and tremendous grit, of our driver to take the Gypsy across safely to high ground. It was a thrilling though somewhat scary experience, and a revelation too.

Be it shifting sand dunes in the west or shifting rivers in the north-east, building and maintaining roads in our border areas pose challenges of the kind rarely encountered in any other civil engineering works. Yet there is one organisation in the coun-

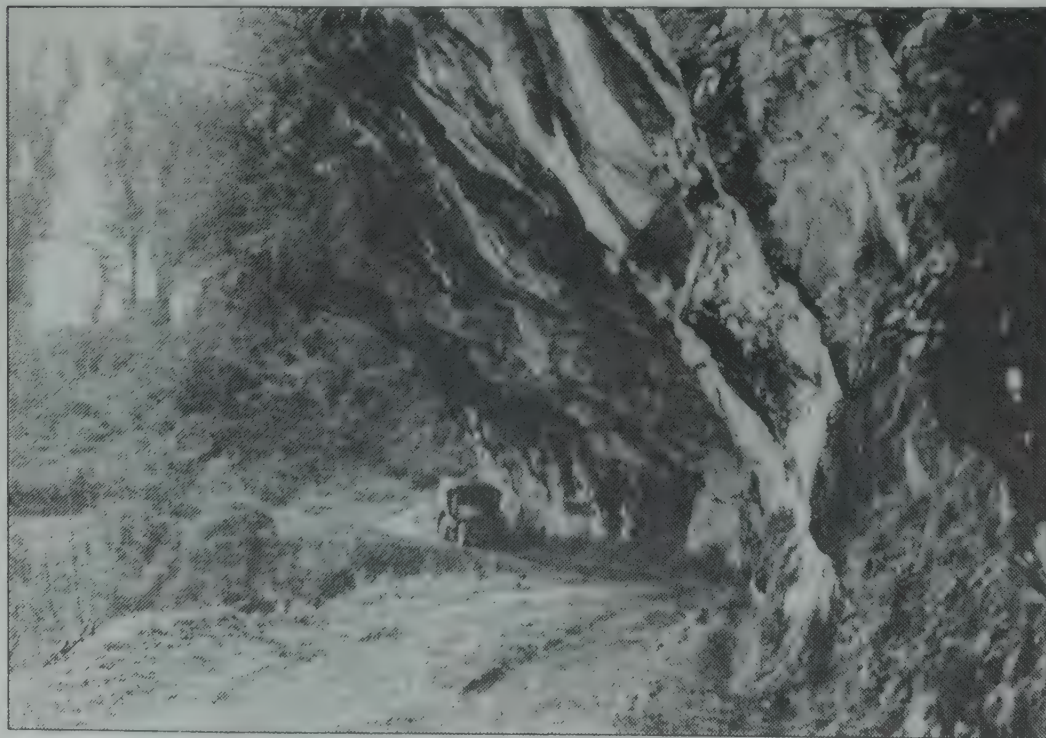
try, the Border Roads Organisation (BRO), that has not only taken up the challenge but has the rare distinction of having completed almost all the assignments within the specified time targets. Working mostly in inhospitable, tough terrains, and often left to the mercy of the elements, the engineers and men of the BRO have an incredible track record of having completed more than 20,000 km of roads linking our far-flung border areas with the heartland in the past 30 years. Today, on an average, it gives to the nation 700 km of good surfaced roads every year, and also maintains most of them.

Although it operates mostly in the border areas, BRO is not an outfit of

BIMAN BASU



Height of Cut! Unable to find another suitable alignment the road was cut 30 m through this sedimentary rock. The bulldozer was inducted right at the top. For scale note the Jonga and human figures at the bottom



A rock-cut structure called 'half tunnel' on the Roeing-Hunli-Anini road in Arunachal Pradesh. The road has literally been scooped out of the rock face

the Defence Services. Rather it is a unique organisation that "works shoulder to shoulder with the Army and civilians in war and peace." We were told that maintenance, clearance and road repair work goes on even when heavy shelling may be going on by the enemy in times of war. The technical personnel of the BRO are drawn from the General Reserve Engineer Force (GREF), which was originally created in early 1943 and rendered signal service in road construction and communications during the Second World War in Burma and Eastern India. GREF was disbanded in 1944, but it was revived again in 1960 with formation of the BRO.

Often, when the BRO took up an assignment it had nothing to go by. Said Commanding Officer Teg Singh of Project Chetak, "When we came to build roads in the deserts nobody knew how it was to be done. Even the Public Works Department (PWD) didn't know how to go about. But we did it and it was an experience in itself." Indeed, an experience it must

have been as we could see for ourselves.

As any civil engineer would tell you, water is vital for any road construction work, for preparing the solid base. But in deserts water is a rare commodity. "Water has often to be brought from as far as 50-60 km away by tankers," said K.T. Chaubal, Chief Engineer of Project Chetak. Not only that, even stone chips have to be transported from distant quarries, at times 100 km away. Naturally, it called for the highest degree of coordination among the different groups involved in executing the work. Another problem encountered in the construction of roads in the desert is that of extreme heat. The bitumen mix used for black topping has to be just right. Says Chaubal, "We use a slightly more viscous bitumen, with a aggregate-to-bitumen ratio of 4.5% to prevent bleeding of bitumen in hot weather. The mix is preheated to 165-170°C for best results."

What about standard specifications? We asked Colonel Koshy Thomas of Project Chetak. "BRO" he said, "has adopted the Indian Road Congress specifications. In deserts, it is not advisable to do much cutting,

Roads Go Green

ROAD building is by and large a forest guzzling activity. To lay a fresh road in remote areas, first of all, it involves the clearing of a long linear path where the road surface will come. Later, when the black topping of the road surface is done large quantities of wood are used to heat the stone chips and bitumen. The black topping activity is a recurring phenomenon for the riding surface needs to be changed every time it wears out.

Today, environment friendly procedures are being slowly adopted to avoid this unnecessary plunder of the green gold. 'Bitumen Emulsions' offer a solution to this burning problem! There is no need to heat these emulsions along with the stone aggregates before laying the black top surface. Known quantities of emulsion (either anionic or cationic depending on the chemical nature of the stones) is mixed with the chips in an ordinary concrete mixer. The prepared stone chips are then carried to the road site and simply rolled over using a heavy roller. It is difficult to make out the difference be-

tween a 'bitumen emulsion' surface and a 'hot mix surface'. On NH 44 the *Science Reporter* team had an occasion to look at one such experimental stretch.

There are other advantages also of using bitumen emulsion. The chips need not be completely dry before applying the bitumen as is required in the hot mix method. Keeping stone chips and aggregates dry in the ever wet climate of the north-east is a nightmare for road engineers. Moreover, the emulsion black top surface 'it is said' has a longer life in wet conditions.

It is not that emulsions are a panacea. These are rather expensive as compared to traditional hot mix bitumen. In addition the emulsion has a very short shelf-life — only about 10-15 days — so work has to go on at a very rapid pace.

It is hoped that the ongoing research in bitumen emulsion would come out with solutions to some of these problems. For, these may become the mainstay for black-topping in the years to come.

Biman Basu & Pallava Bagla

BIMAN BASU



The menace of shifting sand. A modified farm tractor at work to clear the road

rather it is more important to ensure sand stabilization before the road is laid." We saw ample evidence of this philosophy as we drove along several hundred kilometres of black-topped road that snaked through the undulating landscape of dunes and valleys in the Thar Desert.

But, in deserts merely building a good road is not enough, because it has many enemies. Overtopping of entire stretches under shifting sand is, of course, the main problem which is most acute during summer when a violent sandstorm may continue without break for days. Sometimes sand piles up as high as 10 m which presents a Herculean task for BRO men to clear. "It is as if mountains were moving about," said Thomas. The other threat comes from wind erosion which may eat away the 1m wide unmetalled

India Can Do It

berm of the road leaving the black-topped surface vulnerable to rapid degradation.

Once sand gets on the road, no doubt it has to be removed. But how does one get along? Unlike ordinary soil which can be scooped out in large chunks, removing dry sand presents a formidable problem. BRO engineers have found an ingenious way to tackle the problem. They use the ordinary farm tractor with a metal blade attached behind it which just scrapes the sand away. Manual labour is also extensively used at times. "The sand

only that, depending upon the weather, especially in the rainy season, the link may remain cut off for days as the river channels become too swollen for safe crossing, or entire mountainsides may crumble making the road impassable. To keep the vital supply links open the BRO deploys motorized ferries for river crossings and bulldozers at strategic points on the mountains to clear landslides within the shortest possible time. At a few places, however, the elephant still remains the only safe means of crossing the river!

But nothing tests the mettle of

PALLAVA BAGLA

PALLAVA BAGLA



A real time photo of a rock-face being blasted. Limited blasting is done to loosen the rock

BRO engineers more than the construction of new roads on the rugged mountainous terrain of the northeast. Not only are the mountainsides heavily forested here, but they are also fragile and prone to heavy landslides. No wonder, the BRO has lost several hundred men in the past many years trying to tame the treacherous

PALLAVA BAGLA



Drilling into the solid rock face using pneumatic drills. The drill holes are then charged with dynamite for blasting

must be cleared upto a width of 20 m from the road," said Thomas, "otherwise it comes back."

Compared to the hot deserts of Rajasthan, the mountains and rivers of the northeast present a far bigger challenge for BRO men. As we learnt the hard way, roads simply do not link places in that part of the country — they may be interrupted by an uncounted number of river channels, which have to be crossed, or landslides which have to be cleared. Not

The blasted rock and rubble being cleared using a bulldozer. Mechanised operations accelerate the pace of work



PALLAVA BAGLA



Mechanised paving operation. The bitumen aggregate mix prepared at a hot-mix plant is quickly transported on tipper trucks to the site of operation

mountains. In fact, as an organisation, the BRO has the highest and largest number of service and gallantry citations outside the regular Army.

The work on a fresh road begins with what is known as "Reconnaissance, Survey and Trace Cut (RSTC). Survey teams of a few men are first sent out on foot to find the best alignment of the road for the specified requirement. Braving the rigours of

Heavy road rollers at work. Even compaction is necessary to provide a good riding surface



PALLAVA BAGLA

travelling on foot these men mark out the proposed alignment with little red flags. This is followed by a trace cut which roughly delineates the road on the mountainside. A final decision on alignment, however, has to await a thorough examination of the alternatives. For this the BRO makes use of digital terrain models prepared from maps based on remote sensing and satellite imagery, and the computer facility of the Survey of India. Once the final alignment is decided, Formation Cutting activity is taken up.

Formation Cutting is the most crucial, and risky, part of mountain road

PALLAVA BAGLA



A mechanised paver spreads an even carpet of the bitumen - aggregate mixture on the prepared road surface

building for it involves cutting right into the mountainside. It mainly involves blasting and clearing of the rubble with dozers. Said Brigadier S.C.K. Puri, Chief Engineer, Project Udayak, "blasting is done on a very, very restricted scale because it leads to weakening of the mountainside. It is in our own interest to keep the sides as intact as possible".

It is amazing how the men who charge the blast holes are able to assess accurately the right amount of explosive needed to do the job. When we reached a worksite, a few kilometres from Walong in Arunachal

A Landslide Victory

Highway engineers have to constantly battle with the elements of nature. Recurring landslides are probably one of the biggest stumbling blocks in the smooth flow of traffic in hilly areas. There is a constant battle to clear the road of these natural road blocks. The *Science Reporter* team had an opportunity to visit the Sonepur slide site, a mega land-slide which has as of now been mitigated with the use of state-of-the-art technology.

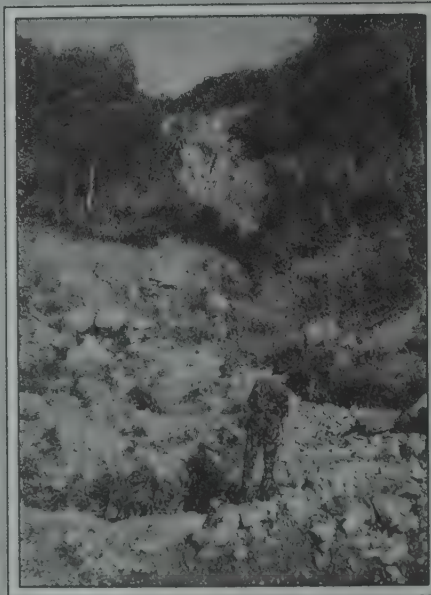
The Sonepur slide site lies on the Shillong to Agartala highway, also known as the National Highway 44, which is the lifeline for the four picturesque states of Meghalaya, Tripura, Manipur, Mizoram and also the Cachar district of Assam. Any break in this lifeline would starve these states of the bulk essential commodities transported by road. "Even a day's break on this highway can lead to traffic jams as long as five kilometres" said Mr Suraj Prakash, Officer Commanding, Road Construction Coy., looking after this sector. On the 25th of June, 1988 there was a massive slide at Sonepur on this highway. Almost half a kilometre length of this vital link collapsed and there was debris as much as 13-15 metre high on the road mostly of large boulders, full trees and mud.

The road had to be closed for over two months while clearing operations were on to remove the 50,000 cubic metres of debris! The Border Roads Organisation lost one bulldozer in this massive operation. For-

tunately, there was no loss of life.

A landslide of this magnitude could remain a cause for constant worry for many years to come, till the slope stabilizes once again. Surveys were done by the Geological Survey of India and the Central Building Research Institute, Roorkee and they estab-

PALLAVA BAGLA



The Sonepur slide site

lished that the slide occurred as a result of the loss of cohesion and the massive mudflow occurred because of excessive percolation of rain water leading to a supersaturation of the overburden. It seems one whole mountain face had collapsed as a result of saturation with water. For, on this fateful day there had been 43 centimetres of rain! As a consequence of all this the weight increased tremendously and the whole mountainside collapsed.

Today, five years after this disaster

it is very difficult to even spot the Sonepur slide site on this highway, unless pointed out. To stabilize the slope many steps were taken, which included the channelizing of water down the slope into the river in such a fashion that heavy percolation does not occur. This was done by building sausage walls lined with geotextiles along the entire course of the *nallah*. Geotextiles are preferred over the conventional galvanized iron wire mesh, because these polymer-based nets withstand the damage due to shooting boulders to a much greater extent. To increase the cohesion in mud 'bitumen mulching' was done at regular intervals. This involves the spreading of a lean mixture of bitumen with kerosene which helps in the sticking together of rocks and debris. The best binders of soil are the root systems of plants, hence a massive plantation programme was undertaken at the landslide site. Large trees which had tumbled down with the mudflow have now been replaced by younger, more vigorous treelets.

Today, the Sonepur slide is no longer a cause for worry for the civil engineers, but still a constant watch is kept on it to ensure the safety of the road. A multi-pronged, well executed strategy has helped mitigate this major landslide, much to the relief of the people of the north-east.

Biman Basu & Pallava Bagla

Pradesh near the Chinese border, workers were drilling away on the rock face preparing holes for the dynamite charge. Drilling over, the explosive sticks were deftly put into the holes, some upto a depth of more than metre and a half. The detonators and fuses were then joined up so that all the charges exploded simultaneously—essential for the blast to be fully effective. As we huddled under

cover about 100 metres away the charge went off with a loud boom that reverberated through the mountains. After the smoke and dust settled we could see the pile of rubble where the rockface stood before. As the dozer cleared the rubble, we could see the shape of the road to come.

The rubble created by the blasting is not wasted. "Each stone excavated is used as a resource, for filling, for

example," said Puri, "We also take care that least damage is done to the forests," he said. But at this work site we could see several rows of stacked wood that obviously came from the felled pines. "We do equal amount of afforestation to minimize the damage," assured Puri.

More than building roads on the mountains, it is keeping them servicable which presents a more chal-

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lenging task for BRO men. In a region where the annual rainfall exceeds 1000 cm, soggy mountainsides crumble without warning, often taking a part of the road with them. BRO has evolved protective measures to prevent slides in the most vulnerable areas (See Box : Landslide Victory). To clear a slide within the shortest time bulldozers are kept ready within easy reach of slide-prone areas. "The biggest enemy of the road is water" said, Colonel R. Suryavanshi of Project Dantak. Removal of water from the road surface is a matter of highest priority. For, even the slightest accumulation of water can lead to a quick degradation of the riding surface. To keep this enemy at bay the road maintenance crews spend a lot of time keeping the side drains of the road in good condition. Culverts and bridges also have to be placed at regular intervals on the road to ensure a quick runoff of water.

Roads in the northeast built by the BRO can claim the rare distinction of having the highest density of bridges in the country — almost 13m of bridge per kilometre of road on an average. But the turbulent flow of the rivers rules out construction of permanent bridges in this region. BRO engineers

About This Story

IT has been the endeavour of *Science Reporter* to convey the sheer excitement of science and technology in India exclusively to our readers. It has also been our endeavour to present it firsthand.

The cover story of the current issue was prepared after extensively looking at our Border Roads network. Our team of Biman Basu and Pallava Bagla got sizzled in the near 50°C heat of the Thar Desert at one end and almost got lost in the forests and rivers of Arunachal Pradesh on the China Border at the other. The team was chased by the Border Security Force patrol on the Pakistan border



Bagla (left) and Basu (right) on the China border in Arunachal Pradesh

mistaking them for spies or smugglers! In all our team spent 30 days in the field having driven 2000 kilometers in all. To do this the cooperation extended by the Border Roads Organisation has been unparalleled.

Having travelled on everything from a bulldozer to a luxury Land Rover and from driving on an eight lane highway to bumpy dirt tracks, each and every joint of the team members has been shaken. We shall continue to work as hard or even harder in future to

bring to you stories from far and near, to provide eyewitness accounts which amply demonstrate that "India Can Do It".

G.P. Phondke

have found a better alternative. They make extensive use of Bailey bridges. These are basically bridges built of steel sections which can be easily trans-

ported over mountain roads and assembled on site. We crossed over the longest Bailey bridge in Asia built by the BRO over the river Deopani, just outside the town of Roeing in Arunachal Pradesh. The BRO has also the distinction of building the highest altitude motorable road bridge in the world—the Khardungla bridge in Ladakh. It has even found a place in the Guinness Book of Records!

In the northern, mountainous part of the country, especially in Ladakh BRO has to cope with yet another foe—snow and avalanche that often cut off vital roads for months. Snow clearing is usually done with machines—mostly bulldozers with angled blades, but today special state-of-the-art snow-cutters are also used. These machines have a horizontal rotating cutting drum that feeds the cut snow to a pump and throws it upwards and away through a chute. The magnitude of the work involved can

BIMAN BASU



Asia's longest Bailey bridge. The 286 m long multi-span steel bridge over river Deopani in Arunachal Pradesh

(Continued on page 48)

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Politics of Population

5.5 billion and still going strong, the very survival of the human species may be at stake! Who takes the lead in resolving this crisis, the First World or Third World, debates

PALLAVA BAGLA



SPACESHIP 'Earth' is in great danger! It is being overrun, overexploited, trampled and desecrated at almost all places. In certain regions it is the profligate lifestyles of the people which is causing the strain. In other regions it is the sheer weight and number of human being themselves which is making the 'natural' ecosystem to breakdown. The statistics provided by demographers is most revealing, it took thousands of years for the human population to reach the one billion mark in the year 1830, but only one hundred years for the second billion and thirty years for the third and the last billion was reached in just 12 years. The world population has already crossed the 5.5 billion mark! All in all planet Earth is currently under severe stress.

The debate is endless as to whether is it the large population sizes

in developing countries which cause more damage or is it the high resource consumption of developed countries that is outstripping the carrying capacity of our beloved planet. There is a certain belief that science and technology can offer solutions to some of these pressing problems. It was possibly with this noble aim in mind that the first ever 'Population Summit of the Worlds Scientific Academies' was held at New Delhi in the last week of October. Over fifty different academies of the world got together to deliberate on this vital issue of population. P.N. Tandon, the former Presi-

dent of the Indian National Science Academy (INSA), the driving force behind this large gathering said 'population should not be viewed as an isolated problem and surely not just a number game, it is a complex problem and to tackle it only a multidisciplinary approach can help'. Highlighting the urgency of the situation said S.K. Joshi, President, INSA, in his opening remarks, 'we cannot postpone action on grounds of ignorance.'

The issue of profligate lifestyles of

Bare Facts

A Day in the Life of the World - 1993

100,000,000	acts of intercourse will take place
910,000	conceptions will occur
150,000	abortions will be performed
500	mothers will die as a result of abortion
384,000	babies will be born
1,370	mothers will die of pregnancy-related causes
25,000	infants in the first year of life will die
14,000	children aged 1-4 will die
356,000	adults will become infected with a sexually transmitted disease

The population of the world will increase by 250,000

Roger V. Short



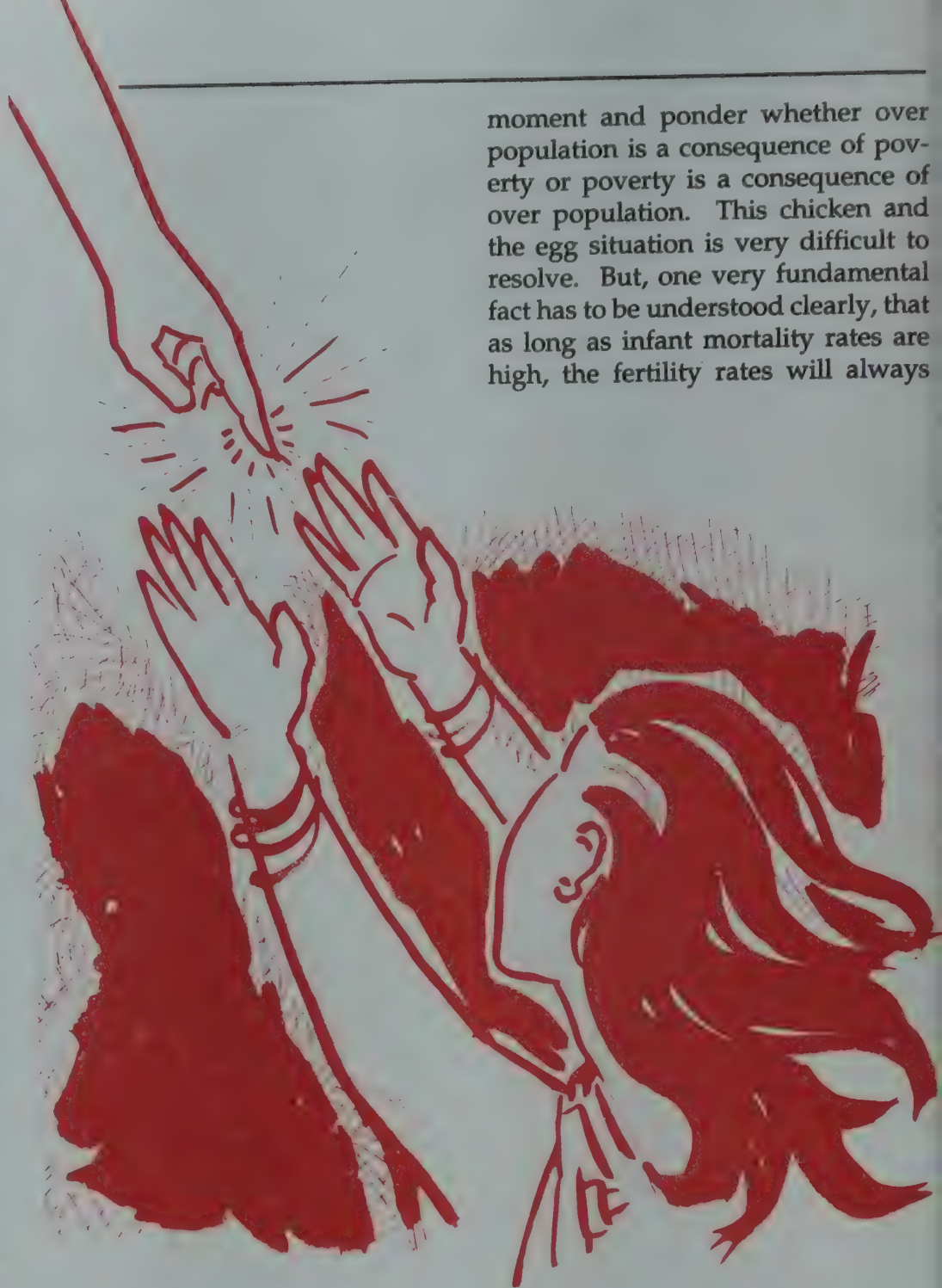
the west versus the large number of human beings in the developing and underdeveloped countries has been a point of discussion for a very long time. "Fifteen per cent of the population shares 79% of the worlds resources leading to severe discrepancies in distribution," said K. Lindahl Kiessling of the Royal Swedish Academy of Sciences. "This certainly cannot go on one would have to think of a fair distribution of these resources, something of the order of a middle income level should be available to all" explained Kiessling. Is this really feasible, will the First World reverse its profligate resource use pattern?

The Third World countries have been the punching bags for the developed nations and they are forever be-

ing accused of despoiling the planet as a result of the massive population growth in their countries. For long the West has been sermonising that unless the population growth rates are cut down in the Third World, the planet is heading for disaster.

THIS holier than thou attitude of West is being strongly contested by a small but vocal group of people. They have been highlighting that just talking of population growth rates and sheer numbers of human beings is not sufficient, what you have to do is to equate these numbers with the per capita resource each one consumes. Norman Myers, a British Consultant on biodiversity, exemplified this point by highlighting that 'even though Bangladesh produces 35 times more people every year as compared to Great Britain, but an average Britisher uses 30 times more fossil fuel as compared to a Bangladeshi'. Hence, it is wrong to pass judgements on any country on its population numbers alone. When one brings in the resource use factor the situation takes a dramatic turn. Imagine a situation where every Indian starts using as much resources as an average American does today ! Estimates suggest that the amount of resources consumed by an average American in one year, can last almost the entire life time of an average person in the Third World ! What is being repeatedly suggested to the Third World by the First World is that you reduce your populations quickly and certainly do not think of developing to the First World levels.

Articulately pleading the case for the Third World H.W.O Okoth-Ogendo of the Centre for African Family Studies, Kenya, said 'even though the total production is going up in Africa the per capita production is constantly going down, due to the rapid rate of increase in population, leading to a poorer lifestyle.' As most contend, this abject poverty in Africa is it only because of increasing popu-



lation ? Ogenda pointed out that this contention is a fallacy and 'poverty of Africa should be looked at from the historical point of view of the exploitation of its resources.' He poignantly explained that 'even though at the moment we know what is to be done but fiscal resources do not seem to permit it at all. Though, the rate of population growth has outstripped the rate of resource generation, still what is happening in Africa has to be viewed as an international development problem not a mere local issue. One cannot just say reduce your population but do nothing for your development'. Here, one should stop for a

moment and ponder whether over population is a consequence of poverty or poverty is a consequence of over population. This chicken and the egg situation is very difficult to resolve. But, one very fundamental fact has to be understood clearly, that as long as infant mortality rates are high, the fertility rates will always

remain high. Because, most people look upon children as a social security-cum-pension plan for old age, to that effect most people prefer to have many children so that at least some of them would survive to adulthood. 'Reducing mortality rates and in particular increasing the chances of survival of children could possibly be the only solution to halting this alarming growth of population' said Herman Bondi of the Royal Society, London. 'The linkage between adult literacy and more significantly higher female literacy to the drop in fertility levels has been amply demonstrated at many places in the world. To make school-

Summary Of The Population Statement

THE academies of the world call upon the governments and international decision-makers, especially those at the 1994 UN International Conference on Population and Development to be held at Cairo, to take incisive action now and adopt an integrated policy on population and sustainable development on a global scale.

The world is undergoing an unprecedented population expansion. Within the span of a single lifetime it has more than doubled to 5.5 billion, and even the most optimistic scenarios of lower birth rates lead to a peak of 7.8 billion people in the middle of the next century. In the last decade food production from both land and sea declined relative to world population growth.

The relationships between human

population, economic development and natural environment are complex and not fully understood. Nonetheless, there is no doubt that the threat to the ecosystem is linked to population size and resource use. Increasing greenhouse gas emissions, ozone depletion and acid rain, loss of biodiversity, deforestation and loss of topsoil, shortages of water, food and fuel indicate how the natural systems are being pushed ever closer to their limits. Both rich and poor countries add to environmental damage through industrial activity, inappropriate agricultural practices, population concentration, and inadequate and inattentive environmental concern. Yet development is a legitimate expectation of less developed and transitional countries.

Our common goal is the improve-

ment of the quality of life for all, both now and succeeding generations. By this we mean social, economic and personal well-being while preserving fundamental human rights and the ability to live harmoniously in a protected environment. To deal with the social, economic and environmental problems, we must achieve zero population growth within the lifetime of our children.

These goals are achievable given time, political will, intelligent use of science and technology, and human ingenuity. But only if appropriate policy decisions are taken now to bring about the requisite social change.

(56 Academies of the world endorsed this statement issued after the Population Summit)

ing universal is a noble and essential aim for reducing both poverty and

overpopulation, said Bondi.

Roger V. Short of the Monash Uni-

versity, Australia, explained that 'all such efforts of reducing the world population are doomed to failure unless the developed countries provide the funding. This is the price that the developed world must pay for its continuing affluence. A start could be made by allocating 1% of the defence budget of every developed country to family planning assistance.' Even though the need of the hour is for a constant increase in the total overseas development assistance for family planning programmes. The ground reality is quite different, as was pointed out by Nafis Sadiq, Executive Director, United Nations Fund for Population Activity (UNFPA) when she lamented that 'the international assistance for the population programme has not increased in real terms at all in this last decade'.

In a style which is his very own Short exclaimed 'Let's make Love, not war!' Modifying this phrase to suit the needs in India one can say 'make love, not babies'!

□



For Her

Beauty At What Cost?

Health risks
may far outweigh
the lift-up
given by a
breast implant says
SUKANYADATTA

OBSESSION with the body beautiful knows no limits. It has reached epic proportions and till date at least shows little signs of waning. While many choose to starve themselves to the point of no return others induce vomiting to throw-up all they have eaten. Still others volunteer for the surgeon's scalpel to fashion for them a body in conformity with the style in vogue. So it matters little if nature was grudging in bestowing her favours or downright unkind — thanks to plastic surgery one could almost have a body made to order.

Breast augmentation using implants is now around thirty years of age. The earliest augmentation surgeries done in Japan and US in the late 50's and 60's relied on injections of paraffin or silicon oil which in those days were considered to be safe. Silicon is a synthetic polymer which has a silicon-oxygen backbone and organic sidechains. It has enjoyed widespread use and today's improved version of yesterday's implants routinely use silicon gel in a silicone rubber capsule. Other implants such as wrist joints, eye and the penile implants are made of similar substances. Users have indicated a marked preference to silicone gel of the natural 'look and feel'. In the USA alone an estimated two million silicone gel implants have given recipients the poise, confidence and body contour that they craved. But into this happy schemes of dreams realized under the surgeon's knife has crept an ominous shadow of

doubt. It is not known for certain how often silicone implants rupture but it is clear that they do not last a lifetime. And an implant may leak even without rupturing. As early as in the 1970s Japanese researchers first raised the voice of doubt about the much touted safety of silicone. They found that women given injections of silicone suffered from severe cases of inflammation and associated problems. Several reports about silicone implants and autoimmune diseases were reported in 1980s but plastic surgeons, manufacturers and some women defended their use. Only about five years back did the US Food & Drug Administration (FDA) get cracking on the fact that leaking silicone implants could be a health hazard. Last year the FDA banned silicone gel implants, limiting them primarily to reconstructive surgery undertaken after the removal of cancerous breasts (otherwise known as mastectomy). Last year, Dow Corning, the biggest manufacturer of the implants, was hauled to court and it was found that the manufacturer had concealed evidence linking ruptured implants to immune disorders. The claimant was awarded \$ 7.3 million in damages.

Most women with breast implants develop aching joints, fatigue, rashes and swollen lymph nodes. Others report, in addition, an ugly thickening of the skin. Called scleroderma it could be fatal when it affects internal organs. Many also reported 'rheumatoid arthritis and systemic erythematosus, a condition affecting the skin, joints, lungs and kidneys. All these diseases involved chronic and widespread inflammation — the ultimate result of an immune system acting against the body's own tissue.

Proving that leaking silicone implants were behind the disorders was difficult but tantalising circumstantial evidence did seem to point that way. It has been known for long that macrophages or scavenger cells that normally roam around in the body devouring damaged or infected cells swarm around silicone implants and fuse into what are

called 'foreign body granulomas'. Granulomas containing silicone have been detected in the lymph nodes which are the central organs of the immune system. But the role of these granulomas in triggering the autoimmune response remains to be elucidated.

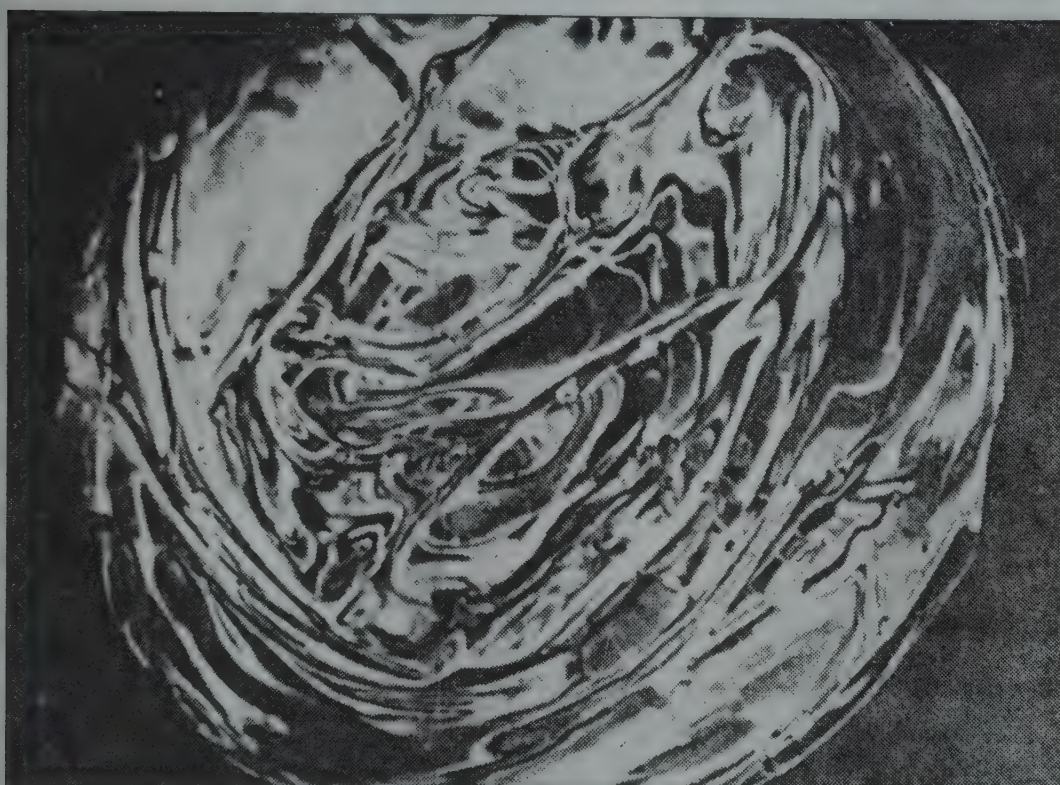
Silicone implants are being studied in an attempt to understand how they might be involved in causing autoimmune disorder. Many theories are being propounded and there could be an element of truth in all of them. The most obvious explanation would be that the immune system treats silicone as 'foreign' or 'non-self' and

foreign and the duped immune system would produce antibodies against it. If the antibodies could react with normal (non-denatured) proteins the ability to distinguish between 'self' and 'non-self' would have been lost leading to autoimmune diseases.

Another school of thought suggests that silicone is not the primary culprit in triggering autoimmune reactions but that it only boosts up the response of antibodies to particular antigens. The mode of adjuvant action is still far from being clear. Traditional theory holds that they act as a depot pinning down antigens so that

in the body. However, doctors are not ruling out a connection (however remote) between the local response and a widespread one. Silicone gel implants are more mobile and reactive hence breast implant inflammation is usually more severe than hard silicone implants elsewhere. With a world wide alarm being sounded many women opted to have salt water implants instead of silicone oil implants. But here too, despite keyhole surgery (Endoscopic Bilateral Augmentation Mammoplasty to give it its correct name) and minimal time required there are problems to be faced. Saline implants are specially prone to leaking and over 10 years there is a 6 per cent chance that an implant will rupture. The implant may harden although steroids are injected to minimize the possibility. Scar tissue has also been known to form (although rarely) and saline implants can foster bacterial colonies. For corrective surgery once the saline implants have been positioned, the surgeon cannot reuse the keyhole belly button route.

Considering the many problems that seem to be surfacing it would be ideal if a trial of breast implants is held. This could follow a group of women who have had surgery and a control group for at least the decade or so that it takes for symptoms to develop. But given the very nature of the surgery, those wishing to undergo the process for cosmetic reasons alone may not agree to wait for the results of the study. Under the circumstances where hard facts are only slowly being gleaned and the prospects of debilitating disease looms large what counsel does one give to those who hanker for the perfect figure? Perhaps none, apart from underlining the need for awareness before tinkering with the body.



Artificial breast for a post-mastectomy patient is a silastic bag filled with silicone gel

mounts an all-out immune response against it in the form of specific antibodies acting against the gel leaking from an implant. The formation of such antibodies could signal the early stages of a widespread immune reaction. In fact specific antisilicone antibodies have already been isolated.

Another theory proposes that the immune system is provoked not by the silicone itself but by proteins interacting with silicone when proteins come into contact with a silicone surface they uncoil and spread out over it. The denatured proteins would be sensed as being

antibody producing cells have a chance to gather and scan the scene. They also act as a "chemotactic" agent signalling immune cells to gather.

The last of the theories being discussed centres on the chronic inflammation some women suffer around the site of the implant. They experience immune responses only at the implant site and not elsewhere in the body. In fact chronic local inflammation around hard silicone implants in the wrists which leads to pain and bone degradation are known. But even this does not lead to severe responses everywhere

Dr Sukanya Datta is with the Publications and Information Directorate, Dr. K.S. Krishnan Marg, New Delhi - 110 012

The Dangerous Alliance

Tuberculosis and AIDS

INDIA'S poor and malnourished seem to be sitting on a ticking bomb. As if they don't have their fill of miseries, they may soon have to face fresh and vigorous onslaught of tuberculosis (TB) due to the spread of AIDS. A warning by the World Health Organisation (WHO) is worrying the health managers in the country. WHO has warned that tuberculosis incidence in the country may increase steeply due to the rapid spread of the HIV (Human Immune deficiency Virus) among our people. This trend has already caused a somewhat hopeless situation in the Sub-Saharan Africa and has also been observed in the USA since 1990. According to WHO, it is only a matter of time before a similar scenario starts to unfold in India and Thailand.

There is another dimension to this problem. *Mycobacter tuberculosis* bacteria which cause TB, are also known to have become resistant to the drugs usually used to cure the disease. This means that doctors and researchers will have to find other ways — perhaps a vaccine or a new generation of drugs — to fight the disease. Till then it is TB which will rule. The seriousness of this problem can be gauged by the recent regulations issued by the New York city's health department which asks TB patients to be detained for at least two years!

As such, tuberculosis is not new to India. It has been a major problem in

the country since ages, claiming lakhs of lives every year. Today nearly 320 million (about 40% of all Indians) harbour the bacillus and every year about 1.2 million new cases are added. Still, since the last decade or so, we have largely managed to contain the disease, thanks to an aggressive anti-TB programme launched by the Government. An effective drug treatment, a certain degree of isolation of the affected and health education are essential parts of this programme. But all those who harbour the TB bacteria do not develop the disease. The body's defence system consisting of a whole arrange of immune system cells largely manages to keep the infection in check. The disease flares up only if the immune system becomes lethargic or ineffective. And this commonly happens in the malnourished, in those under stress or suffering from other chronic diseases. In fact, this induced weakness of the immune system is often considered as the commonest reason for the occurrence of TB.

Keeping the above in mind, the close simultaneous infection of TB and HIV is not surprising. The HIV-virus causing AIDS worms its way into blood cells, cripples the immune system, and makes the body an easy target for the TB bacilli or any other disease causing germ which might be lying latent in the body tissues. Incidentally, TB is also the first indication of HIV-infection.

Tuberculosis and the rapidly spreading AIDS, together, can be very dangerous, says BAKHTAVER S. MAHAJAN



Gradually, data are being collected about the close and treacherous association of AIDS and TB. Consider the following numbers released by WHO and the Centre for Disease Control, Atlanta, USA. It is estimated that already more than 3 million people are infected with both HIV-virus and the tuberculosis bacillus. Of these, 2.4 million are in the Sub-Saharan Africa (which has a frightening figure of 48% of HIV infection) and the remaining have spread out in rest of the world. Further, in the last four to five years, cent per cent increase in TB incidence has been reported in other African countries, too. Devastation in Africa is near-total: up to 55% of those affected with TB bacillus also carry the HIV virus.

The twin diseases are also sharply on the rise in the developed world. Nearly 2 million cases with dual infections were reported in 1991 from the five industrialised countries, and the numbers are constantly rising.

Indeed, the dual dangers of TB and HIV infection, on one hand, and the

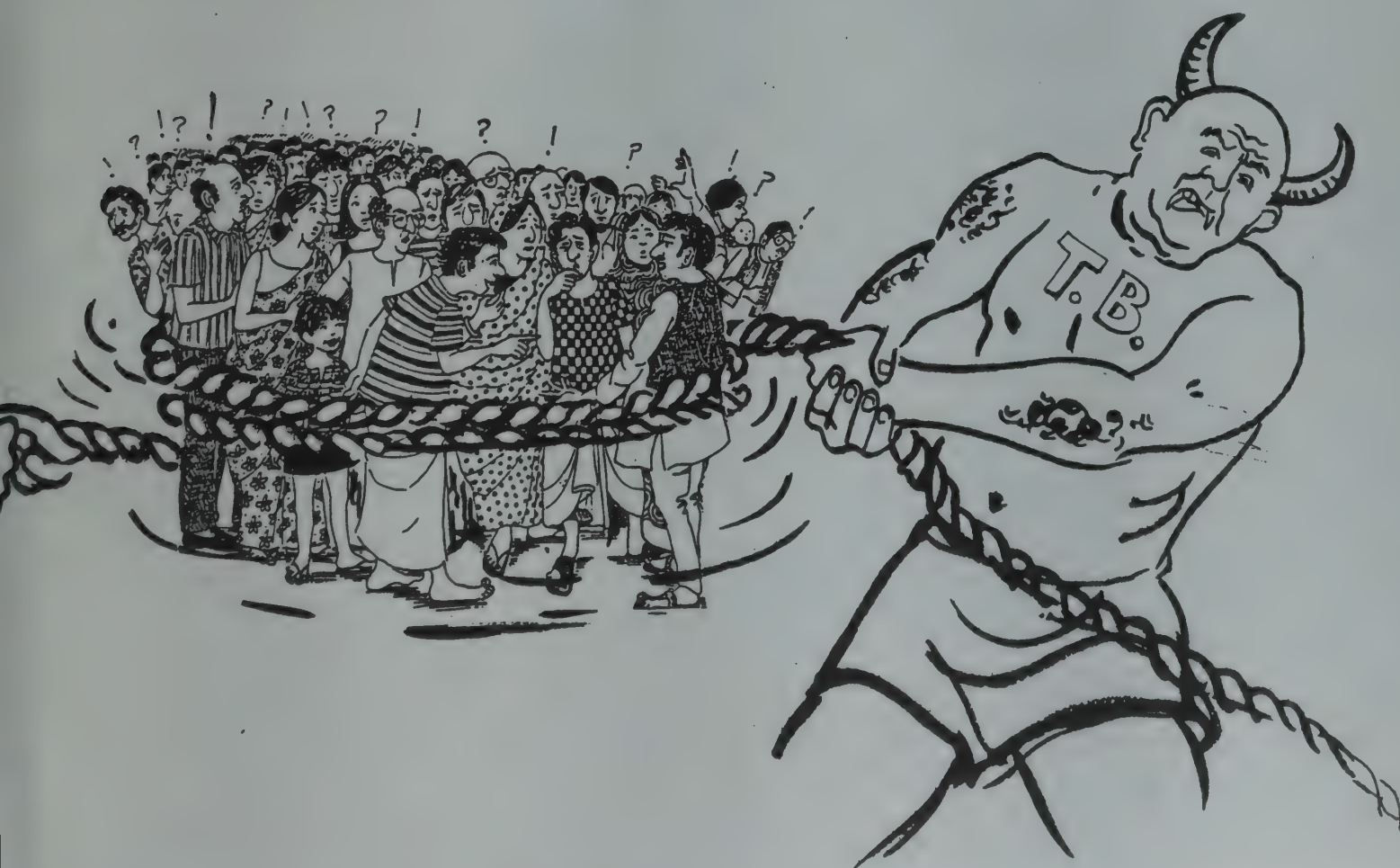
drug-resistance in *M. tuberculosis*, on the other, has caused a near-panic in several Western countries. This drastic step of detention of TB patients in New York has been taken because the health officials believe that the inability of patients to complete their drug-treatment is contributing to the development of resistant bacterial strains. Detention can force people to complete the long course of anti-TB drugs.

Further, in 1991, when TB staged a come-back in the USA, the two common anti-TB drugs (streptomycin and para-amino salicylate) were not available in the US markets. For, as a matter of policy, major drug companies had stopped production of TB drugs since the disease had acquired the status of a "perfectly treatable relic". Similar situation also prevailed then for drugs of several other infectious diseases. Somehow, till very recently, focus had shifted to production of anti-viral and anti-cancer drugs; research on production of newer or better anti-microbials and the phenomenon of drug-resistance had acquired

a secondary status. Physicians thought that they possessed enough drugs and antibiotics to fight all the infectious diseases. However, now a reassessment of this policy is underway. A recent case of polio in Holland and the ensuing scarcity of polio vaccines has further underscored a rethinking of this policy.

Worried physicians and researchers in the US and in Japan have now set up informal networks for monitoring drug-resistance in different microorganisms. An international data-base and a data-management programme to help scientists keep track of drug resistance among microorganisms and report new drug-resistant strains on an international communication network is also on the anvil.

Coming back to India, the health authorities at home seem to be aware of the dual dangers of HIV and TB. This is indicated in the Government's decision to revamp the 30-year old TB control programmes in the country. The Union Health Ministry's annual report (1992-93) also makes a mention



A Persistent Problem

TUBERCULOSIS has been and will be one of the major killers of the human race. Eight million new cases occur every year, 91% of them in developing countries. According to WHO, 2.9 million die each year from this preventable disease. But since 1986 this problem had been swept aside since the "cure" for TB was known.

Our understanding of the disease came in 1882 when Robert Koch isolated the bacteria which cause the disease. At that time the disease was raging in epidemic proportions and was considered as the greatest single killer of the human race. With the rapid spread of industrialisation, the disease played havoc in the West, especially among the poor immigrants from villages who crowded the cities for jobs in factories and mills. Till then, tuberculosis was considered as a non-contagious disease, and this idea, in turn, contributed to a still more rapid spread of the disease. People coughed, spat and shared common cups and plates and other toiletries. Remarkably, with improved sanitation, rising standards of living and finally Koch's proof regarding the disease's contagiousness, the death rates dramatically declined. Remember, this without any drug-treatment.

When in 1952 three anti-TB drugs were introduced, the death rates in the West came down even more dramatically, to an extent that people presumed that TB would shortly be eradicated. Yet, the present resurgence of the disease in the West indicates that the situation is not that simple.

In the meanwhile, the cycle of events which triggered the TB epidemic in the West in the early 19th century seemed to overwhelm the developing countries, including India. The

classical TB setting consisting of poverty, overcrowding, malnutrition, unhygienic and unsanitary conditions, was all around. (And these conditions exist today, too.) Death rate is specially high in densely populated and poor countries.

Age, sex, heredity and physical constitution seem to play a determining role in individual susceptibility and severity of infection. There are some typical signs and symptoms of the disease. Some of these include, fatigue, persistent cough, weight loss, often accompanied by blood-stained sputum. These tell-tale signs prompt physicians to undertake chest X-rays and tuberculin tests for detection of the disease. Presence of bacteria in the sputum or patches in the lungs indicates the onset of disease. Treatment consists of essentially bed rest, nutritious diet, hygienic environment and chemotherapy. Some of the drugs used for curing the disease include, rifampicin, isoniazid, para-aminosalicylic acid and streptomycin, used individually or in combination.

Different species of mycobacter infect cattle, swine and fowl causing tuberculosis in them. Those infecting cattle and swine also infect humans. This should impress upon the reader the importance of boiling milk and preferably taking pasteurised milk and thoroughly cooking meat, preferably in a pressure cooker.

Lungs seem to be the preferred site of colonisation for this bacteria, though *M. tuberculosis* can comfortably lodge in several other body parts too. Some of the other affected organs can be lymph nodes, bones and joints, serous surface, genital organs, kidneys, skin and intestines.

B.S.M.

infected persons have been put on 9 months of short course anti-TB therapy and their progress is being watched. At the National Institute of Virology (NIV) at Pune, of the 269 HIV positive persons, 11 had TB.

Tuberculosis patients are also being followed up systematically for possible HIV infection. All cases of TB reported at TRC, Madras, and TB sanatorium at Vellore were screened for this purpose. Of the 3071 TB patients tested during 1991, 12 were detected positive for HIV's presence. At the NIV, Pune, 4 out of 359 TB patients tested positive for HIV. These numbers are deceptively low and indicate that at least, as of now, TB does not seem to be associated with HIV. But such a situation may not last long and we cannot afford to be complacent on this front.

The implications of a possible spread of AIDS accompanied by TB are grave and frightening. The AIDS-HIV infection is spreading fast in the country, with nearly one million HIV carriers, and a TB epidemic does not seem to be far behind. Chances of effectively fighting TB (or AIDS) are going to be tough due to the rapid spread of drug resistant bacteria (not taking into consideration the financial constraints on the system). Faced with such a situation, health officials are advocating a holistic approach. As stated by the Deputy Director General of the Indian Council of Medical Research, the official health agency advising the government on health related issues, "...its impact must be visualised in the context of social and economic problems which plague the country..." Communication and education, besides increased research efforts in understanding the phenomenon of drug-resistance in different microorganisms, prudent use of existing drugs, new anti-microbial agents, and above all greater public awareness can go a long way in fighting this problem.

Dr Mahajan is a scientist with the Homi Bhabha Centre for Science Education, TIFR, Bombay

of the possible resurgence of TB. At the Tuberculosis Research Centre (TRC) at Madras, 220 HIV positive patients were followed for the development of TB. Of these, 115 showed abnormal chest radiographs and the

aputum of 34 among these had *M. tuberculosis*. Another 34 had grown non-tuberculosis mycobacter. Tuberculin reaction (a sure test for the presence of TB bacilli) of 12mm or more was seen in 113 patients (51%). 42

The Man Who Shaped The Scientific Revolution

THE LIFE OF ISAAC NEWTON by Richard S. Westfall (*Cambridge University Press*, published in India by *Foundation Books*, 2/19, Ansari Road, New Delhi), 1993, Pp. 328, Rs 195; **ISAAC NEWTON : ADVENTURE IN THOUGHT** by A. Rupert Hall (*Blackwell Publishers*, Oxford, UK), 1992, Pp 468, Price not mentioned.

"NATURE and Nature's laws lay hid in night: / God said, Let Newton be ! and all was light."

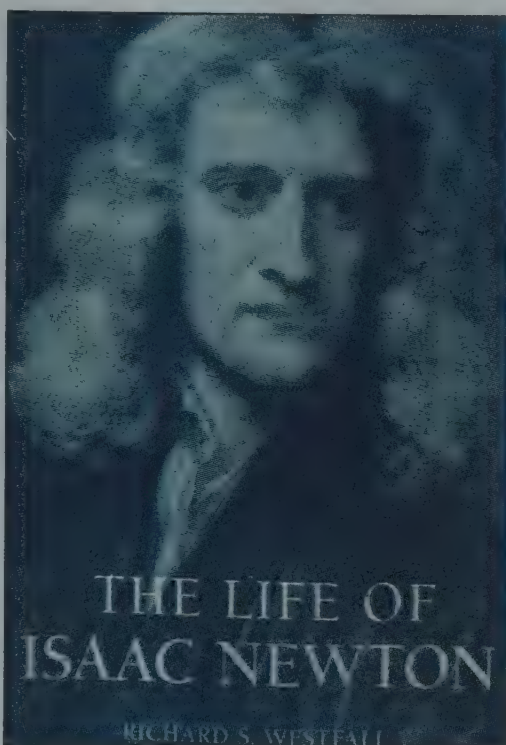
This was the celebrated couplet Alexander Pope wrote in 1727 for inscription on Isaac Newton's tomb. Alas, Westminster Abbey would not accept it. Pope however published a slightly modified version in 1755. Few scientists have received from poets encomiums of the kind Sir Isaac received. Nearly three hundred years later Newton's biographies have become a cottage industry for historians of science. Newton's first real biographer though was Sir David Brewster, the Scottish physicist who did seminal work on diffraction of light.

The story of Newton's life and discoveries has been greatly enriched as well as altered by scholars exploring his huge manuscripts during the past 30 years. The two titles under review are by eminent historians of science who have ploughed through published and unpublished literature and Newton's correspondence.

Biographies of scientists by historians of science are a genre by themselves. In attempting to give a fully rounded picture of scientists they see in their subjects what scientist-biographers are likely to overlook. Yet, the more a historian focusses on his speciality the less he is able to portray the scientist. Richard Westfall and Rupert Hall have tried to maintain an agreeable balance between science and

history, although the historian in them jets out occasionally. Westfall's *The Life of Isaac Newton* is a shortened version of the same author's *Never at Rest* published in 1980. His aim was to make the biography more accessible to the general audience by pruning mathematics to the barest minimum.

Historians of science attach a great deal of importance to the year 1642. Galileo, on whose discoveries much of Newton's own career rests, had



earlier died and Isaac was born on the Christmas day, although it was 4 January 1643 on the Continent. Westfall and Hall both trace Newton's childhood in Lincolnshire to his career at Cambridge, where his genius flowered forth. Born prematurely, after his father's death, Isaac was a frail and sickly child. Yet he was a sober, silent, thinking lad. His interest and ability in experimentation while still quite young bordered on the precocious. Both biographies span roughly 15 chapters.

Newton's interests, as any student

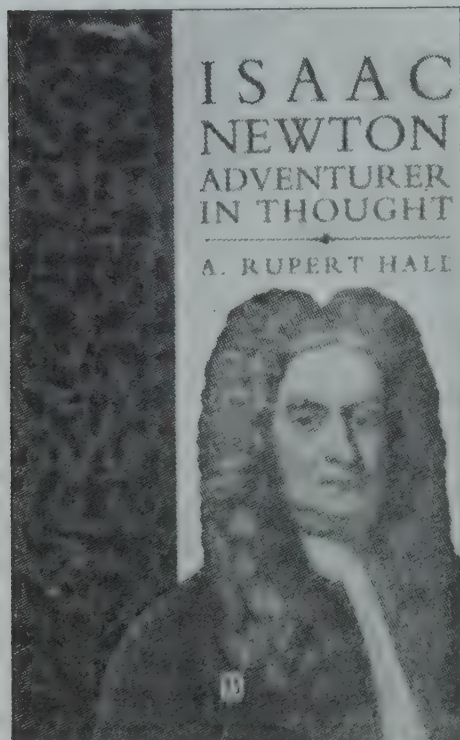
of science would know, embraced not only mathematics and physics, but alchemy, theology, history and natural philosophy. As a civil servant he attained the status of a public figure. Westfall observes that Newton explored natural philosophy from several vantage points ranging from mathematical physics to alchemy. In natural philosophy he gave new directions to optics, mechanics and celestial dynamics, and invented the mathematical tool that enabled modern science to explore further the paths he first blazed. Never a man of half-hearted pursuits, he had the perseverance of a hedgehog.

Who were the earliest to influence Isaac ? Hall notes that the greatest experimental, philosophical and chemical influence upon Newton from his undergraduate days was that of Robert Boyle, although the two had never met or corresponded before Newton was admitted to the fellowship of the Royal Society. Another person, of a very different type, who was to play a major role in Newton's life was the Scott David Gregory. At Trinity College, Cambridge, Isaac is reputed to have studied mathematics under Isaac Barrow whom Newton succeeded as Lucasian Professor of mathematics (1669) and whose lectures on methods of drawing tangents and finding areas inspired Newton to attack these problems in his own inimitable style. The result was the invention of fluxions (differential calculus, as we now know) and inverse method (integral calculus). Westfall's research, however, finds that Barrow was not Newton's tutor and there is no evidence of any familiarity between them at this time.

The great part of Newton's original work in mathematics and science, according to Hall, was first expressed in the form of original lectures. This is true of his researches in geometrical and experimental optics, of his investigations in algebra and some other parts of mathematics. He never, it seems, lectured upon calculus. Why ? Because he believed that the topic was beyond the reach of his students. Nor

did he lecture either upon his chemical, alchemical, biblical or historical studies. For he felt the subjects lay outside the scope of his professorship.

The greatest landmark in Newton's scientific career, nay, in science's course, was the publication in Latin of *Philosophie Naturalis Principia Mathematica*, better known as the *Principia*. Translated in English it stands for the Mathematical Principles



of Natural Philosophy. Almost from the moment of its publication, even those who refused to accept its central concept of action at a distance, recognised it as an epoch-making tome. It was indeed the turning point for both Newton himself and natural philosophy, as Westfall would remark. Edmond Halley of Comet Halley fame, who was chiefly responsible for its publication, reviewed it anonymously in *Philosophical Transactions* before its actual publication. The other landmark was the publication of *Opticks*, written in prose rather than geometry, was accessible to a wider audience than the *Principia*.

Through the eighteenth century it dominated the science of optics with almost tyrannical authority and exer-

cised a broader influence over natural science than the *Principia* did.

The relationship between Sir Isaac and the Royal Society is an interesting facet of Newton the man. True, he dedicated his magnum opus to this august body in 1687. But he ignored it steadfastly until his own election as President in 1703. Once at the helm of the society's affairs, he became one of the longest-serving presidents and also the most diligent, dictatorial and intolerant of opposition, as Hall observes. Newton's contribution to the Royal Society as its president, Westfall notes, was administrative rather than intellectual, although administration involved intellectual matters.

What surfaces from the two biographies as well as from other accounts is that Newton the man is not an enviable person, to put it euphemistically. Despite his debt to Halley, a debt beyond payment, Newton refrained from supporting him to the Savilian Professorship of astronomy at Oxford but went on to recommend David Gregory, who was well known to be a Newton flatterer.

Adding spice to the Newton story are the legendary hostilities between him and his arch-rival Leibniz on the priority over the invention of calculus on the one hand, and between him and Robert Hooke on diffraction on the other. Between Westfall and Hall, the former is less sympathetic to Newton. According to Hall, Westfall's complaint that "Newton owed his very first knowledge of diffraction to Hook's discourse" is ill-founded. In private correspondence, however, Newton was full of lofty sentiments. Praising Hooke's contribution to optics, Newton produced what has become one of the most memorable quotes: "... If I have seen further it is by standing on y^e shoulders of Giants."

Like every Christian of his age, Newton believed that the universe had been created by God in six days. That God is the author and sustainer

of all-things Newton decisively maintained in the final pages of *Opticks*.

A few more glimpses into the life of the enigmatic genius who shaped the revolution in modern science. Sir Isaac was reluctant to publish his researches despite the fact that *Principia* brought him name and fame. The reason: he did not like controversies, especially priority claims over discoveries.

By the end of 1676, being absorbed in theology and alchemy and distracted by criticism on optics and mathematics, the colossus had virtually cut himself off from the scientific community. Even as President of the Royal Society, Sir Isaac did not find it easy to express fundamental convictions in public. He feared criticism.

The oddest thing in Newton's life is that the story of the apple and gravitation is not apocryphal, says Hall. Westfall also admits that the incident is too well attested to be thrown out of court. He however laments that the story vulgarises universal gravitation by treating it as a bright idea. "A bright idea cannot shape a scientific tradition," comments Westfall.

Between Westfall's and Hall's biographies of Newton, readers will find the latter more lively. This is because Hall makes no apology for not perpetuating obsolete writing contractions like y^e and w^{ch}. Students of history of science would find the two books more profitable than students of science.

P.S. Shankar

SCIENCE IN 21st CENTURY by Dilip M. Salwi, Konark Publishers Pvt. Ltd., A-149, Main Vikas Marg, Delhi-110092, Pp. 298, Rs 125.00. (Paperback)

PHENOMENAL advances made in science and technology have influenced many aspects of life of the modern man. Many technologies which are currently undergoing trial

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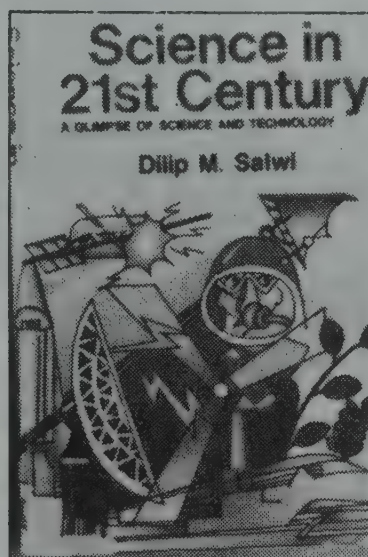
are expected to materialise in the near future. However, some technologies, if used with an evil end, can also bring catastrophe to mankind. The pros and cons of all future technologies must therefore be weighed carefully before they are given green signal for development on a mass scale. Proper monitoring of technologies is therefore a must and those likely to act against the interest of mankind and world at large may better be shelved. The book is an attempt to foresee what direction the future science and technology may take in the 21st century. It attempts to provide a glimpse into the future and acquaint readers with the rapid strides made in space, transportation, energy, adventure sports, weaponry and environment.

Space technology has not only provided satellites that perform a variety of important tasks, including remote sensing, but has made possible setting up of space stations too. They provide laboratories in space in which various experiments can be performed. Also, processing of new materials in space has become possible, thanks to these laboratories. Efforts are also on to build space colonies. Besides electric cars, hovercraft and flying trains, the future might also see an aerospace plane. An ecologically sound, economically cheap and a uniquely efficient transport vehicle will be the need of the hour in the coming century. A bicycle, although it appears to be a crude means of transport, has the potential of fulfilling all these requirements.

There is no gainsaying that in the 21st century too energy will continue to play a crucial role. Rather energy is expected to throw more challenges to us. Research is being directed at harnessing energy from the sun, oceans, wind and earth's interior. Besides these non-conventional energy sources, scientists are also trying to generate energy through fusion. Coal, a conventional energy source known to mankind from prehistoric times, is

also expected to stage a comeback. Hydrogen, the most commonly known gas, is expected to be the future fuel as it creates less pollution and is easy to produce.

Of late, environment has drawn considerable attention. Unless the factors responsible for pollution or those posing a threat to the ecological balance are controlled, we would not leave behind a safe and clean planet for posterity. Oil spills, acid rain, high voltage transmission lines, etc, have become a cause of concern to environmentalists. Even space has not been spared. The space junk is of serious concern to all space-faring countries. The thinning of ozone layer, leading to the creation of 'ozone hole' due to the effect of chemicals, such as chlorofluorocarbons, has raised a new



environmental problem.

Technology has made strides in adventure sports too. Man-powered flying machines, hang-gliders and balloons have over the years undergone considerable changes in their design and functioning. With a view to solve water problems in the coming century, scientists are planning to haul icebergs from the polar regions to distant places. Also, in processing water from the sea, the improved desalination plants will now be used. Sewage will now be used after recycling for a variety of purposes such as agriculture, fish cultivation and fuel. Food will be processed by radiation using

the technique called 'radappertisation'.

Besides, the book also talks about development of new materials such as composites, carbon fibres, etc., which find wide applications from household goods to medical care. Biotechnology, superconductivity and green or environment-friendly technologies have also been dealt with. Frontier fields such as the development of intelligent robots, communication with Extra Terrestrial Intelligent (ETI) civilisations, and breakthroughs made in the field of communication using optical fibres have also been discussed in the book.

Some technologies, however, can prove perilous to mankind. Cruise missiles, killer satellites, laser weapons, etc, developed for use in military warfare can have drastic consequences bringing a nuclear threat to the entire world. These and various other technologies which can have disastrous effects on human existence must be viewed with caution.

The book attempts to introduce to the common man the challenges and opportunities that the 21st century is likely to offer him or her. Written in a popular language it will no doubt succeed in its aim. Besides the common man it would be of interest to sociologists, economists, and environmentalists. However, some minor errors and omissions have been left in the book. The author has erroneously used 'Liquid Petroleum Gas' for LPG (p. 98) whereas it should be Liquefied Petroleum Gas. A notable achievement made in the field of fusion research has also been overlooked. On November 9, 1991, a team of scientists led by Paul-Henry Rebut of the Joint European Torus (JET) succeeded in producing about one megawatt of power for two seconds from nuclear fusion. The book also does not discuss cryogenic rockets. Nonetheless, the book is a must for anyone desirous of keeping himself abreast of the latest advances made in science and technology.

P. K. Mukherjee

THE GOLEM - What Everyone Should Know About Science by Harry Collins and Trevor Pinch, *Cambridge University Press* (Available from: *Foundation Books*, 2/19, Ansari Road, Daryaganj, New Delhi-110 002), Pp. 164, Rs. 150.00

FROM school and college days we imbibe the feeling that science is sacred, it is the search for truth, and to extract even one 'truth' from nature scientists sacrifice their entire life. As a result scientists appear to be puritans, lovers of truth, and honest, well meaning persons. Also, scientific theories, laws and principles appear to be irrevocable truths which have been handed over to us after they have been tried and tested over the years. However, in reality this image of science and scientists is far from correct. Science is not a sacred cow, nor its theories, laws and principles are the last words. Every aspect of science is open to questioning and doubts. In fact, to question the very facts of science is what science is all about.

Besides, it is completely forgotten that science is after all a human affair. Science that eventually reaches the press and percolates down to textbooks is created by humans, tested and verified by humans, and recognised and accepted by humans. This entire process of creation of science is therefore naturally prone to human errors. Scientists, with their weakness for power, fame and money, can favour a scientist's ideas of some other scientist because he is a non-entity. The present cut-throat competition for credits, honours, awards and research grants further make scientists prone to jealousies, infighting and even frauds. The book under review titled 'Golem' after a Jewish mythological creature with features similar to science highlights all these dark aspects of modern science by documenting well known case histories.

Naturally, the case histories are of controversial scientific findings in different fields. Take the first case of chemical transfer of memory. Experiments conducted by James V.

McConnell and Georges Ungar in the 50s and 70s indicated that the transfer of memory through chemicals was possible. It was observed that a worm learnt to respond to a particular stimulus if it was injected with the mashed extract of a trained worm. This finding was attributed to the transfer of memory chemicals from the trained worm to the untrained one. This experiment was so simple to perform that even school and college students did it in their laboratories and homes. However, the results were not consistent. It soon dawned upon the experiments that the learning abilities of worms was dependent not only upon their skills but also on several external parameters as many as seventy in number! Nevertheless, as Ungar was an influential name in the field, he continued to pursue this line of research and extended it to mammals. This line of research died only when he died at the late age of 70! This case history clearly shows how a simple experiment can be misinterpreted to indicate some revolutionary findings and how the findings continued to receive grants for further research as long as an influential scientist continues to believe them!

Take the second case history of the 'proofs' of the Theory of Relativity. It is believed that Albert Einstein's Theory of Relativity was laid on firm foundation by two major and now well known experiments, the Michelson-Morley experiment meant to detect ether in 1917 and the A.S. Eddington's observation of the 1919 solar eclipse to detect bending of starlight. Further investigations have shown that the result and observations of both these experiments are inconclusive. The Michelson-Morley experiment does not decisively prove that the velocity of light is constant in all directions and that ether does not exist! On the other hand, A.S. Eddington's telescopic setup to observe the solar eclipse had considerable experimental errors. The setup was not sensitive enough to measure the bending of starlight by the massive gravity of the sun. Of course, these two instances do not indicate that the Theory of Relativity is wrong.

they only show how a theory is instantly accepted when a much publicized experiment conducted by an authority like A.S. Eddington proves it correct. And once it is widely accepted all the subsequent experimenters compete with each other in proving the theory correct. Infact all the initial resistance peters away, and those experiments that show anomalous results are considered noise and ignored!

Similarly, the authors have taken the case histories of other scientific controversies such as cold fusion, gravitational waves, solar neutrinos, the spontaneous origin of life, etc. Through elaborate discussions on these case histories, they have shown how sometimes scientists consciously or unconsciously tamper with data to prove or disprove a theory or to obtain huge grants for research; how sometimes luck plays a vital role in the acceptance of a theory; how press conferences can sometimes influence the course of scientific research; how observations on animals made under laboratory conditions become authentic versions of their behaviour in the wild; how difficult it is for a scientist to gain acceptance for his theory without the backing of a clout or an influential scientist; and so on. In the conclusions, the authors have shown that scientific research is something like an experiment done in a school laboratory. If a teacher asks ten students to find out the boiling point of water, each student would come forth with different value depending upon the accuracy of his thermometers, the purity of water and other conditions prevailing in the laboratory. However, the last word on the boiling point of water rests with the school teacher who brings order to the prevailing chaos.

The book, as the sub-title claims, is indeed a must for every science student especially if he is aspiring to take up research as a career. In any case, any idealist science student would become worldly-wise after reading this thoroughly gripping book.

Dilip M. Salwi

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Why does a razor blade pressed between fingers fly off when released ?

*Dibyendu Khar
Mankundu (W.B.)*

Shaving blade, which is made up of steel experiences spring action when we try to bend it with our fingers. Like a spring the blade also resists the force trying to change it's shape, and when this force is removed due to spring action recovers it's original shape. This is because the material used to make the blade is elastic like steel and rubber. When we remove the force which tries to change it's shape, the blade tries to regain it's original shape by making it's body straight again, in this process it gains forward momentum and moves forward. The action of catapults and bows used for shooting arrows also depends on springiness in the same way. also when a diver produces sufficient force by jumping to bend the board downward. The spring-board springing back to its original shape gives the diver powerful upward thrust which helps him in diving.



Neeru Vig

Why is an easy chair more comfortable than an ordinary chair?

*Amal Kumar Mondal
Santiniketan (W.B.)*



Whether a person feels comfortable on a chair or not depends upon how much of his body area is in contact with the chair. For instance, when a person sits on an ordinary chair or stool, only its seat is in contact with his body. His entire body weights therefore, presses down on a small area. The pressure per unit area at the seat of the chair is high. He, therefore, feels uncomfortable. However, when a person sits on an easy chair, almost his entire body is in contact with the chair. His entire body weight, therefore, gets uniformly distributed all over the chair. The pressure per unit area on his body is at minimum. He is, therefore, comfortable.

Dilip M. Salwi

Why do we use sand to fry groundnuts in a pan instead of heating them directly in the pan?

*P. C. V. Harinee
Hyderabad (A.P.)*

The process of dry frying or roasting, frying in oil or boiling is more or less the same. The basic principle is to cook the food-stuff by giving almost uniform heat for a long time from all sides of the material being cooked. Same is true for groundnuts also when we roast them in sand in a pan. Since sand is a good absorber of heat it can be heated to quite high temperature very quickly and it maintains this temperature for a long time. When we put groundnuts in heated sand, they get roasted uniformly from all the surfaces and also from inside without getting their outer surfaces burnt. If we try to roast them by putting directly in a pan, the outer surface which is in direct contact with the pan will get burnt in no time and the inner core will remain unroasted. Same could be done by roasting groundnuts in heated air, but the heat holding capacity of air is very low. Hence we use heated sand instead of air.

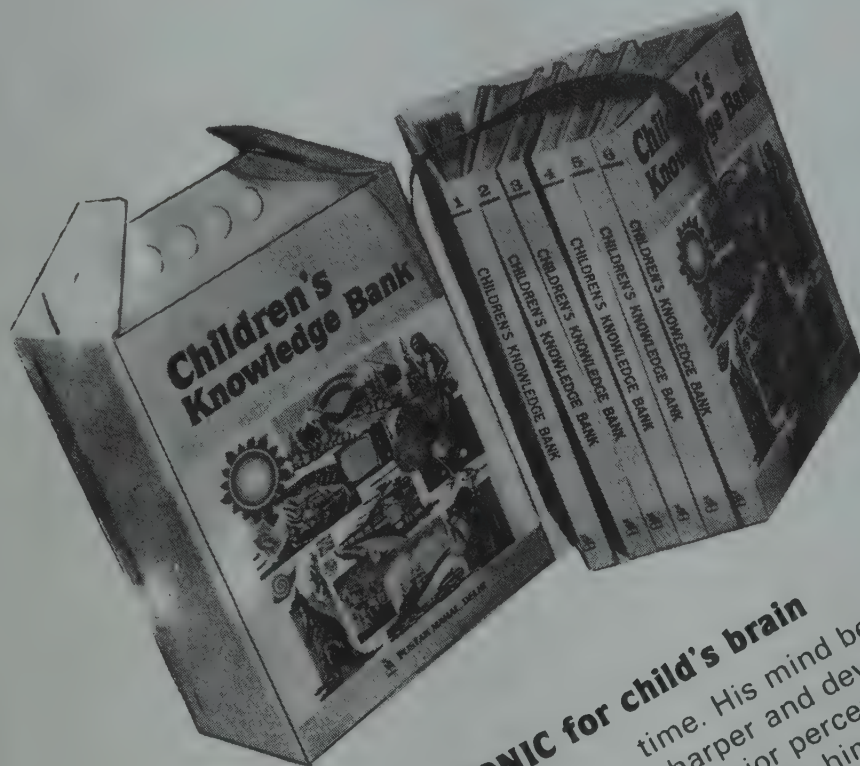
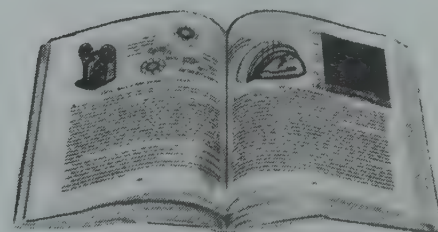


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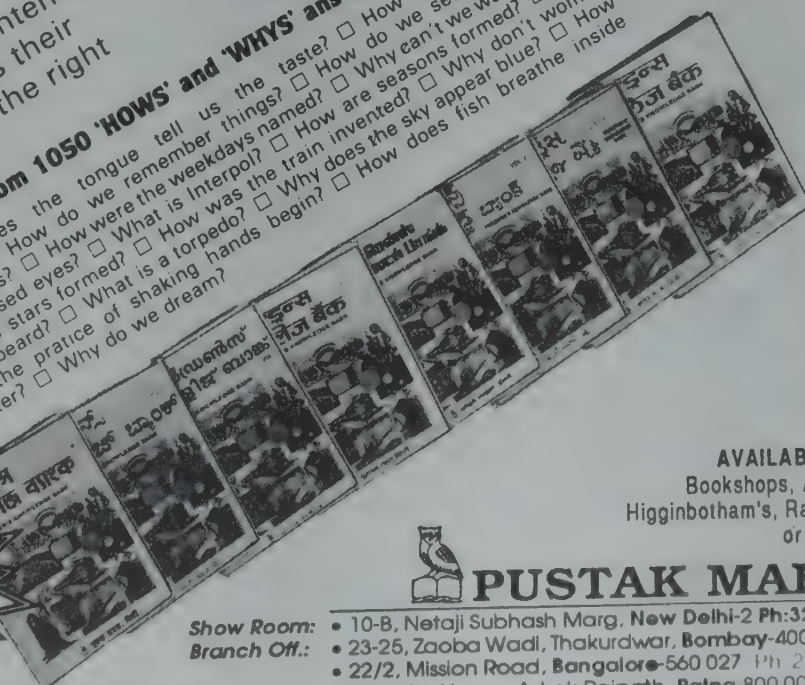
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How does food get cooked quickly in a pressure cooker?

Kundan Ghosh
Calcutta (W.B.)

Generally we cook food in water. For that we boil water with raw food in it. Raw food gets heat from the boiling water and softens. Any liquid boils when the vapour pressure of the liquid equals the atmospheric pressure above the surface of the liquid. And the temperature at which this happens is called the boiling temperature of the liquid. Boiling temperature of water under normal conditions is about 100°C . When we cook food in water in pressure cooker, the atmospheric pressure above the surface of the water increases and hence now water boils at higher temperature — approximately at 200°C . So raw food gets more heat and hence is cooked quickly. Cooking in a pressure cooker is a very economic way of cooking and also since the food is heated for only a short time it remains more nutritious than that cooked in other ways.

Neeru Vig



Why are lightning bolts in the sky always seen as a zig-zag line?

Neeta Choudhary
Basti (Bihar)

Lightning bolts are nothing but flashes of light produced by electric discharges of high intensity in the atmosphere. The friction of rising hot air with the cool condensed water vapour in the clouds strips water molecules of electrons and builds up a positive electric charge. This induces a build up of opposite negative charges at the nearest point on the ground. The build-up of electric charges takes place in a step-by-step manner, from the top of clouds to the base. When the intensity of charges on the cloud exceeds a critical limit, an electric discharge occurs. The discharge occurs between a point of high potential to the next lower potential. Thus a series of random discharges occur and reach the base of the cloud. This process is called the 'leader discharge'. Finally all the accumulated charges are discharged to the ground which is with opposite charges. Now, a reverse flow of electrons occurs from the ground to the cloud, along the same random path. The extreme speed of this high voltage current produces flashes which we call the lightning. Since the flow of current is random, the lightning bolt always looks wavy and never a straight line.

Kollegala Sharma



Why do doctors prescribe vitamin tablets along with antibiotics?

Franklin C. Jose
Trivandrum (Kerala)

Doctors prescribe vitamin tablets along with any antibiotic prescription to prevent our body from suffering vitamin deficiency. The antibiotics are powerful chemicals that can kill microorganisms, chiefly bacteria. When ingested these drugs kill not only the disease causing bacteria but also the harmless ones normally residing in our intestines. Called the 'intestinal microflora', these friendly bacteria convert some of the food constituents into vitamin precursors which are absorbed into the body through intestine. But for this help some of the essential vitamins like those of vitamin-B complex will not be available for us, for our body lacks the machinery to convert food constituents into vitamin precursors. Use of powerful antibiotics kill these helpful bacteria and curtail the supply of vitamin precursors to the body. Therefore, in order to keep the body supplied with usual dose of vitamins doctors prescribe ready made easily absorbable vitamin-B tablets along with antibiotics. Vitamins are also believed to help in early recovery from the ailment.

Kollegala Sharma



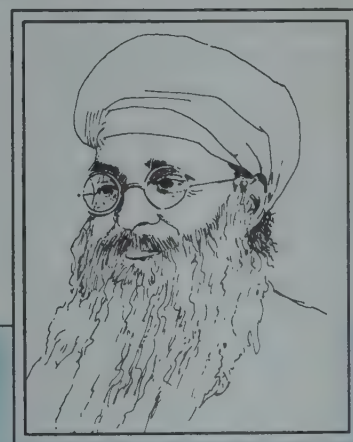
KOLLEGALA SHARMA

Professor Puran Singh

Punjab's
First
Chemist

THE fag end of nineteenth century is a memorable period in the history of India, and for more than one reasons. It was the times when a nationalist fever struck the land ruled by colonialists. It was also the time when the eyes of natives were opened to the exploitation by colonialists of their rightful wealth of natural resources. It was also the time when the people of the land of ancient religions took notice of developments in modern science and education taking place elsewhere in the world. It is at such a period that a new breed of scientists flowered in the subcontinent and founded the base on which the edifice of today's Indian science rests. One such illustrious person was the Punjab chemist Puran Singh. The son of Punjab whom H. S. Virk, his biographer, describes in *The Journal of History of Science In India* as "perhaps the first chemist of eminence born in Punjab", pioneered many chemical ef-

Professor Puran Singh was born on 17 February, 1881 in a small village, Salhad of Abbotabad district in Punjab. The village is now in Pakistan. He was a brilliant student during his school days and passed his F. A. examination from D. A. V. College, Lahore. At that time there was not much opening for further studies in the subcontinent as there were only three Universities, one each at such far off places like Bombay, Calcutta and Madras. The Punjab under Sikh rule had only traditional schools like *Madrassas*, *Pathsalas* and *Chatsals*. The situation did improve a shade when Oriental College was set up at Lahore,



**"Professor Puran Singh was
perhaps the first
Chemist of eminence in Punjab"**

forts, especially in the utilization of forest products and amidst great difficulties. Sadly, today his name remains largely relegated to history books.

after the annexation of Punjab by the British. Here too teaching of science at B.Sc(Hons.) and M.Sc. was not available till the first quarter of twentieth century. Puran Singh, like many other

Unsung Men Of Science

youngsters of that time had to go abroad to further his studies. In 1900 he went to Japan and joined Tokyo University to study pharmaceutical chemistry. No Maharajas came forward to sponsor Puran Singh's studies abroad and all his expenses were met by the funds raised by the enlightened Sikh people of Rawalpindi.

Puran Singh's student days at Tokyo were eventful, if not turbulent. The emotional young man in Singh made him to first to become a Buddhist monk and later forced to change the mind—after a chance encounter with Swami Ram Thirth—and turn into a Vedantin. Religious adventures apart, Puran Singh also dabbled in student politics. He organized an Indo-Japanese club and began publishing a journal called the *Thundering Dawn* through which he strived to project to the outside world the travails of Indians under the colonial rulers. All these activities brought him trouble when he returned home. He was arrested by the British as soon as he landed in Calcutta. But for the pleadings of his parents, he would have spent many years behind bars for such activities. However, his parents got him released and brought him to Lahore.

At Lahore, Puran Singh had to face the reality. He was jobless. There was hardly any opportunity for a foreign trained scientist in those days, although the number of such men compared to the present times was in just hundreds. Besides, he had on him the burden of debt, of the funds his poor parents had sought from their community to finance Puran Singh's studies. All these made Singh determined to put to profit his scientific knowledge. Enterprising as he was, Puran Singh set up a small factory extracting and manufacturing essential oils from geranium and citrus oils. The distillation unit at Anarkali bazar of Lahore was set up not with any sophisticated equipments but earthen and metal pots manufactured by local potters



and blacksmiths. Despite such a crude set up, Puran Singh could obtain excellent results and even began selling his product. Unfortunately, his enterprise failed to sustain as he could not pull together with his business partner for long.

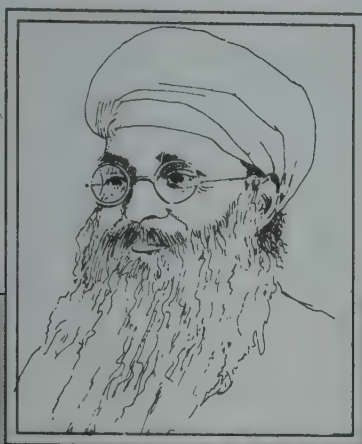
After dismantling the distillation unit at Lahore Puran Singh joined as Principal the Diamond Jubilee Hindu Technical School. Two years later, in 1906, he moved to Dehradun to set up a soap factory which he sold off a year later to join the Forest Research Institute at Dehradun as a chemist. Here he set up his own laboratory in the Department of Chemistry of Forest Products starting from scratch. His interests in essential oils were re-kindled. With the atmosphere being conducive for research and suitable

facilities on hand, Puran Singh delved full time into analysing, extracting and isolating essential oils from many forest trees and plants such as *Eucalyptus globulus*, geranium, winter-green, sandalwood. He also developed a new condenser for distillation of camphor oil. Infact, he was very keen on promoting the essential oils industry in India. Realising that a sound base of Chemistry of essential oils is needed for this, he determined the oil yielding qualities of many oilseeds. He is also known to have devised improved methods of extraction, distillation and purification of turpentine oil from various sources like *Chir* resin, pine trees like *Pinus khasya*, *Pinus merkusii* and *Pinus excelsa*. He pursued these objectives even after his retirement from FRI (he retired much earlier from

FRI on health grounds). After his retirement when he was under the employment of Maharaja Scindia of Gwalior, Puran Singh started cultivation of *Rosha* grass and *Eucalyptus globulus* in barren lands and set up a factory to extract essential oils from these. The oil was being exported to England. The British government was so impressed by these efforts that it gave Puran Singh 15 *morabbas*

and walnut. He also extracted tannins from the Indian Oak (*Terminalia tomentosa*) and Burmese myrobalans. Not only that, for the first time in India, Puran Singh devised a chemical test, using freshly prepared nickel hydroxide, for estimation of tannins. Till then tannins were being estimated crudely by using powdered hide.

Although researches at FRI and his



**"He was a great
visionary, a scientist, humanist
and a mystic poet"**

(squares) of land on lease for cultivation of Rosha grass. His work has also helped the essential oil industry indirectly in many ways. For instance, his determination of oil value of sandalwood from south India and his work on cultivation of and extraction of oil from sandalwood promoted the sandalwood oil industry in India. Puran Singh also collected a variety of oil-seeds from forests and tested their utility as sources of essential oils.

Another industry which benefited from Puran Singh's adventures in chemistry was the fledgling tannin industry in India. Tannins are a group of organic chemicals obtained from plants and used in processing leather. Puran Singh carried out studies on tannins of mangrove (*Rhizophora mucronata*), myrobalans, *Pistacia integerrima*, Arwal (*Cassia auriculata*)

preoccupation with essential oils diverted Puran Singh away from pharmaceutical chemistry — the field in which he had qualified — a close look at his works show that he had not neglected it altogether. For example, he took keen interest in the cultivation of drug yielding plants in the Indian forests. He tried to assess therapeutic value of some essential oils such as sandalwood oil and wintergreen oil.

Chemistry was not the only interest that Puran Singh had. He was also keenly interested in literature and societal problems. For instance, he is known to have wondered at the tendency of some pregnant women to eat earth and suggested that it might be due to reasons similar to the ones which force Indian deer to eat earth — to replenish their body with mineral

salts. Along with a British scientist, Puran Singh also devised a technique for manufacturing charcoal briquets from Indian woods. Some engineers at IIT, New Delhi are now looking into reviving this technique. There is also a patent in Puran Singh's name, of a novel technique for cleaning and discolouring crystal sugar from raw sugar. The technique was immensely liked by the sugar manufacturers of that time as it did away with the use of bone charcoal which was detested by the users for religious reasons.

Puran Singh had invented the novel technique, in a field entirely new to him, at a time when not only facilities but also information in the form of research journals were very hard to come by. His efforts, therefore, were greatly appreciated at the Indian Science Congress (1925) held at Benaras Hindu University, Varanasi.

Puran Singh's literary works run into some two dozen volumes in English, Hindi and Punjabi. According to H. S. Virk, "his writings have a relevance to the present Punjab crisis and provide insights for finding a solution to the problem". "He was a great visionary who predicted the fall of communism and break up of Soviet Union", says Virk. As a poet Puran Singh has written great mystic poems which, he also believed, had the quality of winning a Nobel prize.

Although his scientific pursuits are little recognized in the country of his birth, at that time Puran Singh's efforts were well recognized outside the country. He was a member of the Chemical Society of Japan and Royal Chemical Society of London, two prestigious institutions of chemists. The scientist, humanist and mystic poet died in Dehradun on 31 March 1931 at the age of 50. □

EEG ELECTRICAL EVALUATION OF BRAIN

SURESH NADKARNI

ELECTROENCEPHALOGRAM (E.E.G.) is a brain-child of biomedical engineering. E.E.G. is an important tool of investigation for a neurologist, and is extensively used to precisely locate a lesion.

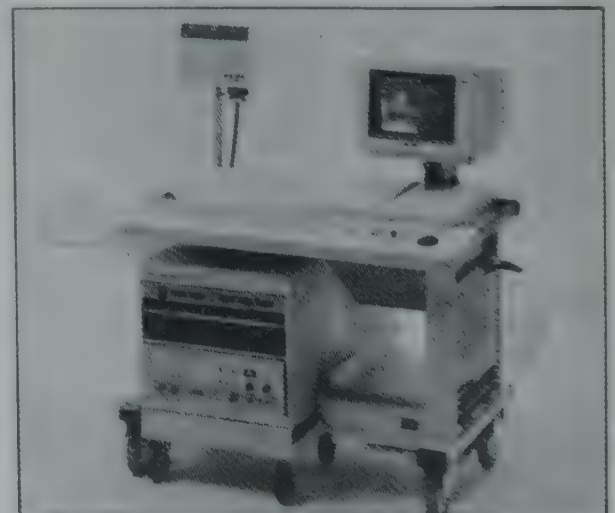
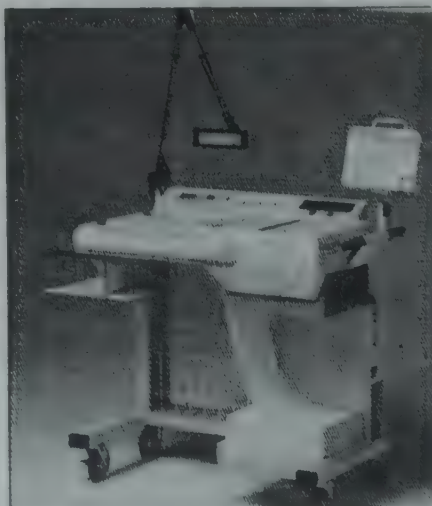
E.E.G., first introduced by Hans Buerger in 1929, is basically a tracing of the electrical impulses of the brain. The machine that records the tracing is an electro-encephalograph. The electric impulses of the brain are detected by means of wires and electrodes over the scalp. The wires are connected to a vacuum tube radio amplifier, which magnifies the impulses more than a million times. The impulses are of sufficient magnitude to move an electromagnetic pen that records the brain waves. The rate, height and length of the waves vary in different parts of the brain. Age and the degree of consciousness also cause the wave patterns to differ.

A brain examination by electro-

encephalograph is harmless and involves no pain or discomfort to the person. It is widely used in studying how the brain works and tracing the connections between the parts of central nervous system. It is of great help in the diagnosis of epilepsy, brain tremors and other diseases and injury to the brain. General diseases like

sleeping sickness could also be diagnosed. However, it is of no value in diagnosis of mental disorders, as there is no gross damage in the brain in such conditions.

Brain activity is modified by several factors such as age of the patient, level of unconsciousness etc. Imaging techniques like MRI cannot assess dys-



The EEG machine

functions of the brain, E.E.G. steps in here admirably.

The basic electrical activity falls into four broad categories. Frequency of the sinusoidal waves determines the category. Alpha activity lies between 8 and 13 Hz (unit measure of frequency). It is the rhythm of the resting or awake brain, which gets attenuated on opening the eyes. Frequency more than 13 Hz is termed as Beta activity. It is a useful sign in the diagnosis of sedative — hypnotic overdosage. Theta is 4-7 Hz rhythm, usually seen in elderly people. It becomes apparent during the early stages of sleep. Delta, less than 4 Hz, is a slow wave activity and is usually seen in sleep, as well as in infancy. Focal or diffuse excess of theta and delta activity may be a pointer to underlying structural disease or dysfunction, of the brain. The E.E.G. of the newborn differs from an adult E.E.G.. E.E.G. 'maturation' starts by the age of three years and is complete by the age of 13-15 years.

Sleep can be studied with the help of E.E.G. For instance, in stage 1 of early sleep, there is a generalised slowing to theta range. In stage 2 sharp waves appear. In this manner the stages of sleep can be ascertained by the help of E.E.G.

Sometimes the brain is specially activated to take the E.E.G. Hyper-

ventilation, photic (light) stimulation and sleep are commonly used activation procedures. Lowering of blood sugar, sleep deprivation and certain chemicals are also deployed for activation. This helps to locate the disease.

For photic stimulation, a stroboscopic light is flashed on closed and open eyes. If the patient is suffering from photosensitive epilepsy, a typical pattern of E.E.G. is seen. Alcohol or drug withdrawal syndrome also is diagnosed on similar lines with such photic stimulation.

In epilepsy, paroxysmal activity of waves is observed. In local epilepsy this activity is also localised. When the surface E.E.G. is not conclusive in detecting focal epileptiform activity, other types of electrodes are inserted through the nose. Even this procedure can fail to reveal the lesion in 15-30% of patients.

In certain diseases, brain damage does occur. For example, in liver diseases, the brain gets damaged. This condition is called hepatoencephalopathy. The typical E.E.G. waves help in the diagnosis of this serious condition. Damage of brain on account of some metals also can be diagnosed with the help of E.E.G.

Intoxication due to sedatives or hypotics is also revealed in comatose patients by a good E.E.G.

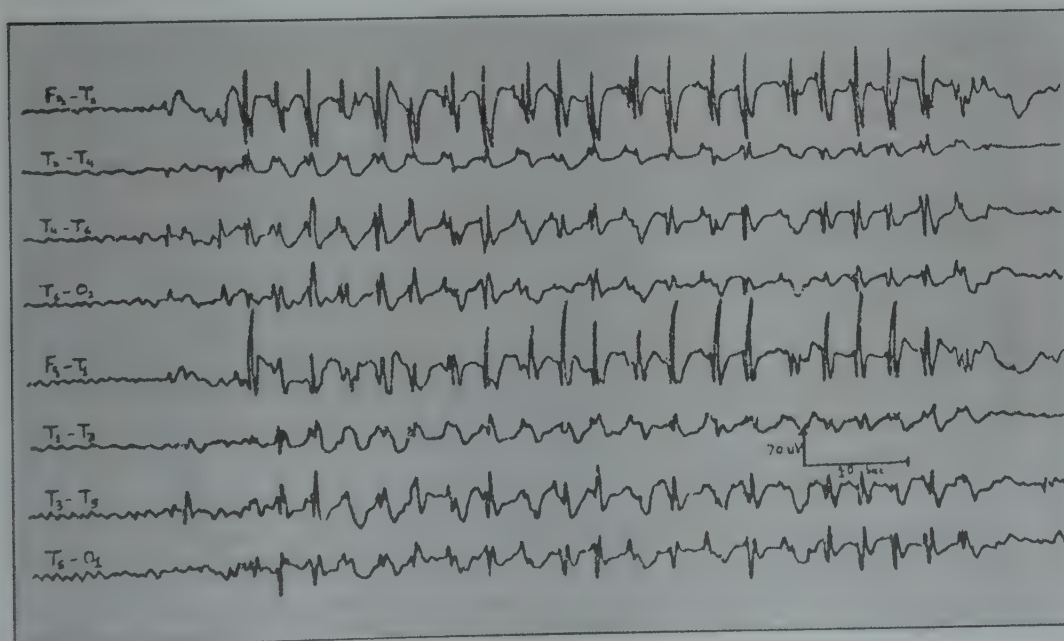
Hypocalciemia or the lowering of blood-calcium, especially occurring on account of thyroid dysfunction, can be detected by E.E.G.

Some virus infections, such as subacute sclerosing panencephalitis, can be ascertained with the help of E.E.G., besides many other diseases, such as Herpes simplex encephalitis or Jacob Creutzfeldt disease.

Sometimes in severe cases the brain dies, however the heart and lungs continue to work. There is no hope of survival of the patient and he continues to live as a 'Vegetable'. Under these circumstances, the relatives of the patient are apprised of the situation by showing them an E.E.G. of the patient's brain that gives a flat waveless graph thus confirming brain death.

E.E.G. is not a time consuming procedure. the routine scalp procedure takes about 30-45 minutes. Hence it is not surprising to get a normal E.E.G. in epileptics, as the brain may be normal during the investigation. E.E.G. can also be recorded in combination with video recording. This procedure is called telemetry. Types of seizures can be recognised in cases of intractable epileptic seizures. Electrodes are also placed in the brain and E.E.G. taken. This delineates the exact focus, thereby helping the surgeon to home in on the epileptic site.

Brain mapping is the computer aided pictorial representation of different rhythms over different parts of the brain. This is comparable to PET and provides a functional image of the brain and helps to localise the origin of abnormal discharges. Thus E.E.G., is now opening new avenues in studying the electrical activities of the brain. Being non-invasive and economical, it's popularity is now advancing.



Dr Nadkarni is a practising physician. Add : Flats 38-39, 5th Floor, Municipal Building, Jobanputra Compound, Nana Chowk, Bombay-400 007

Nobel Prizes—1993

*This time the Americans have swept the Nobel Prizes.
Here is a report*

Physics

THE 1993 Nobel Prize in physics has been awarded to two Princeton Professors, Joseph H. Taylor and Russell Hulse, for the discovery of binary pulsar but for totally different reasons. A pulsar is a heavenly body which, like a lighthouse, beams radio pulses at highly precise intervals. Earlier, the 1974 Nobel Prize in physics was also awarded to Antony Hewish for the discovery of pulsar. No doubt to discover a binary pulsar



Taylor



Hulse

is an achievement in itself but much more than that this discovery confirmed some of the predictions of the Einstein's Theory of Relativity. To do so, it demanded not only considerable mathematical acumen on part of the discoverers but also excellent experimental skills to time the radio pulses accurately. One can imagine how much experimental skills were required to confirm the Theory of Relativity from the fact that 75 millionth of a second shift in a radio pulse was to be measured!

In 1975 Taylor and his young graduate student Hulse, who were then working at the University of Massachusetts, Amherst, U.S.A., discovered

the binary pulsar *PSR 1913 + 16* using the huge 33 metre dish-shaped radio telescope at Arecibo, Puerto Rico. In fact, *PSR 1913 + 16* is the name of the a pulsar which is in an orbit of a massive companion star. Both these bodies are essentially neutron stars which, as the name implies, are composed entirely of neutrons. These are stars which have gravitationally collapsed inwardly to form highly dense and compact bodies. For instance, the neutron stars in this binary system were found to be 1.4 times the mass of the sun but were hardly 20 kilometres in diameter! Further, quite extraordinary for a system of two bodies, the pulsar was found to move at one thousandth the velocity of light around the neutron star, with an orbital period of 7.75 hours! This was an ideal setting for the verification of the Einstein's Theory of Relativity which concerns highly massive bodies moving near the velocity of light. Taylor and Hulse investigated this setting to do just that.

According to the Theory of Relativity two massive bodies moving in

an orbit of each other would lose their kinetic energy and momentum in the form of gravitational waves. With the release of these waves, there would be proportional decrease in their kinetic energy and momentum. In other words, the two bodies would spiral in towards each other, affecting their period of orbit. Taylor and Hulse calculated how much this orbital period would change for the binary pulsar and found it to be 10^{-7} second shift every orbit. Their observations of this change in the period, which accumulated over 14 years comes to 8 seconds, have confirmed the release of gravitational waves within 4 per cent of experimental error. This indirect confirmation of the existence of gravitational waves is highly significant because these waves have not yet been directly observed. In fact, this is the first and only observational evidence for the existence of these waves.

Taylor and Hulse also went on to show that the rate at which radio pulses are emitted by the pulsar is also affected by the presence of its massive companion star. The radio pulses were found to be delayed by 25 microseconds confirming the General Theory of Relativity which predicts that any massive body would bend a beam of light or radio waves passing by it. Today, Taylor continues to pursue pulsars and has discovered many more of their kind, whereas Hulse has shifted to plasma physics, the study of the fourth, ionic state of matter.

Dilip M. Salwi

Chemistry

THIS year's Nobel Prize for Chemistry has been awarded to Kary B. Mullis and Micheal Smith for discoveries that have "hastened the rapid development of genetic engineering".

Mullis, a biochemist, was awarded the Prize for developing a technique called the polymerase chain reaction (PCR). PCR is like a powerful amplifier which can convert even an inau-

dible sound into a mighty roar. This allows scientists to take a microscopic strand of DNA and make millions of identical copies of it within hours, allowing them (scientists) to study something that would otherwise be far too small to examine. Even a cancerous cell would take at least a month to perform the same stupendous task!

The polymerase chain reaction was



Mullis



Smith

conceived by Mullis in 1983 while he was working for Cetus Corporation in California. Today, he works from his home in La Jolla, California. He spends most of his time in surfing, rollerblading and consultancy.

All PCR does is reproduce, in a test tube, the basic biological process of replication, turning it into a chain reaction. The three basic requirements to carry out this process are : the four building blocks of DNA called nucleotides; a polymerase enzyme that copies the DNA by linking the building blocks in correct sequence; and two primer strands, short DNA segments, that bind to the sample at either end of the target sequence and tells the polymerase where to copy.

To start with, the sample is first heated. This separates the two complementary strands of DNA. On cooling the mixture, the primers find their sites on the separated strands, and the polymerase copies each target region. This process of heating and cooling is repeated. The rate at which DNA is copied is exponential. Millions of identical copies are made within minutes.

The PCR method is used in identifying faulty genes in hereditary diseases, and was also employed in discovering the virus that causes AIDS. Scientists can produce DNA from animals that became extinct millions of years ago by using the PCR method on fossil material. The technique has also become indispensable in established fields such as disease diagnosis, forensic analysis, and genome sequencing. In fact, it has revolutionised the human genome project.

Michael Smith has been working at

the University of British Columbia since 1956. He is presently the Director of the University's biotechnology laboratory. He sketched out the Prize-winning experiment with a colleague, Clyde Hutchinson, while having tea in the canteen at the Laboratory of Molecular Biology in Cambridge. His work was rejected by the reputed journal *Cell* earlier whose editor described it as a technical development not of very general interest.

Smith's technique called 'site-directed mutagenesis' was published in 1978. It allows scientists to reprogram the genetic code in a DNA strand, increasing the possibilities of constructing new proteins. Site specific mutagenesis allows scientists to make precise alterations in the sequence of a gene. This gives them an insight into the working of these genes. Such changes in the genetic code are called 'mutations'. Before the discovery of this technique scientists could only produce random mutations. For this they relied on X-rays, ultraviolet light, chemicals, etc. But, now they can choose the site of their choice to produce mutations.

The first step involved in this method is to splice a normal gene into the circular, single stranded DNA of a

virus. Next step involves chemically synthesizing a short segment of DNA which is an exact complement of the normal gene sequence except at a single amino acid coding site. The segment is allowed to bind to the normal gene, forming a short region of double-stranded DNA. A polymerase enzyme completes the second strand, and the double stranded product is inserted into the genome of a bacterium.

With the help of this method scientists can tailor enzymes which can carry out specific functions. For example, imagine making an enzyme that breaks down plastics into harmless by-products. Biotechnology companies routinely use site-specific mutagenesis to create stable proteins required in industries.

Smith is presently using his own technique to study a protein which is involved in cellular respiration, called cytochrome C, and an oxygen storage protein called myoglobin. These two Noble-prize winning discoveries have today changed the face of molecular genetics.

Purnima Rupal

Physiology or Medicine

THE discovery of the structure of Deoxyribonucleic acid (DNA) — the blueprint of all life, by J.D. Watson and F.R.C. Crick in 1953 marks a watershed in molecular biology as it led to the biotechnology revolution and explosive advances in genetics and medicine. An equally epoch-making finding came as a surprise to the scientific community in the spring of 1977. This was none other than the discovery of the highly unusual structure of genes in higher organisms. Just as the discovery of the double helical structure of DNA in one sweep unravelled the mode of expression of the hereditary units and the way they

are copied, the elucidation of the structure of eukaryotic genes sparked a revolution explaining how genes in higher organisms develop during evolution and solved the intriguing puzzle of the origin of some hereditary diseases as well as a few cancers. This work of deciphering gene structure has won the 1993 Nobel Prize for Physiology or Medicine, an award long overdue. The scientists who did this work independent of each other are Richard J. Roberts, Research Director, New England Biolabs, Beverly, Massachusetts, and Phillip Sharp, Head of the Deptt. of Biology, Massachusetts Institute of Technology.

(Continued on page 55)

TEACHING THE BODY TO FIGHT CANCER

MIRA KUSHAL

A man in his fifties comes to a hospital with an abdominal trouble. Doctors recognize it as stomach cancer and perform a surgery. The tumor is removed to ease his discomfort. But that doesn't end his troubles. As often happens the cancer and spread to his liver too, from where it can not be removed. The man had to be sent home without treatment, to die within a few months. But lo! he returns to the hospital three months later for routine evaluation looking much better and also gaining strength. His condition improves.

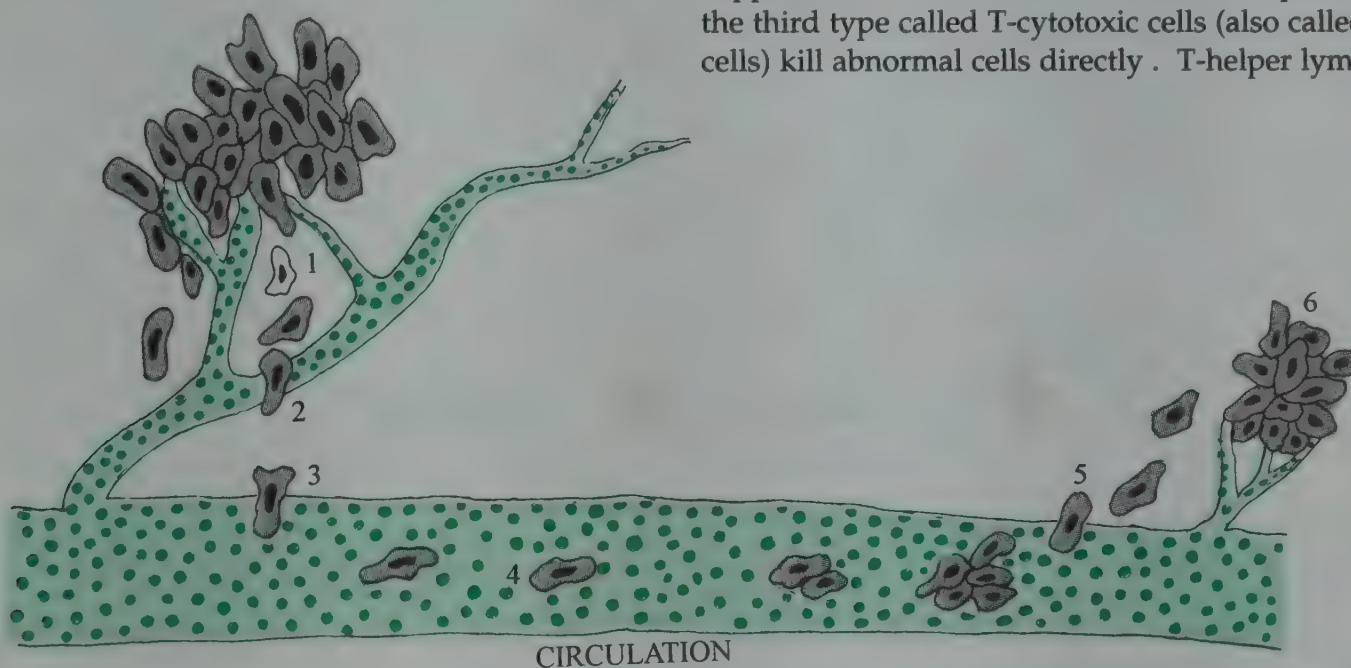
Twelve years later he meets the doctor again, this time complaining of abdominal pain from a gall stone. The doctor finding the patient otherwise fit decides to operate and remove the gall bladder, but is surprised during the operation to find that all evidence of the previous cancer is gone. The cancer had simply disappeared. The body has somehow fought off the cancer without even the help of drugs.

Such instances of spontaneous disappearance of tumours have excited the scientists to look for ways of treating cancer using body's own defence mechanisms against anything that is foreign. such an approach is based on the belief that there is something unique about a cancer cell that distinguishes it from normal cell (thus making it nonself or foreign), and that this difference can be recognised by the body's immune system. A cancer cell, although born of a normal cell, is very different from it. Unlike other tissue cells it can break loose from its parent tumor, penetrate the blood vessels, survive its passage in the bloodstream, emerge at a favourable spot, start another tumour there and induce the growth of new blood vessels to nurture the nascent tumor. In other words, to turn cancerous and a normal cell has to undergo many successive heritable changes or mutations. Thus it comes to have many altered molecular traits on it, which allow it to defy the growth controlling regulatory signals in the body.

Most of the regulatory signals that control the growth and multiplication of normal cell are chiefly found on the cell surface. A cancer cell, because of the altered molecular traits on the cell surface, defies all these regulatory signals and divides uncontrollably, you can even say selfishly, at the expense of its neighbours and in the end destroys the whole cellular society. Many-a-time these altered molecular traits are recognised by the body's immune system and the growth of the tumor is prevented. However, sometimes the system fails or becomes inefficient to cope with the rapid growth of cancer cell. Thus results a cancer.

Immunologists in many laboratories around the world are thinking of various approaches to harness body's own defence mechanisms, that is, increasing the body's immune response to fight cancer. Traditionally benign and malignant tumors have been fought chiefly by surgically removing to remove the discrete mass; by shrinking or killing with the help of ionizing radiations like X-rays or gamma rays the localised cancer not amenable to surgery and by destroying the cancer spread throughout the body using powerful drugs. But, now, immunotherapy which can combat spreading cancer and tumors is being thought of as a better alternative. An important advantage it gives is that the therapy kills the diseased cells selectively and leaves the normal cells unharmed. Drugs are not so specific.

THE idea of fighting cancer by unleashing the latent powers of patient's own immune system is



The spreading menace. Cancer cells can evade detection by the body's defence system and spread to other parts. They dissociate from the original tumour (1 & 2), penetrate the walls of blood vessels and enter circulation (3), move along the blood flow (4) to a different part, get out of the blood vessel (5) and start a secondary tumour

not new. William B Coley's observation in 1930's that killed bacteria injected as vaccine sometimes produced regression of cancer led to a search for arousal of the latent anti-cancer forces in the body by bacterial products and culminated in the identification of tumor necrosis factor. Many researchers seeking to activate the anticancer response even injected patients with their own cancer cells. However, these approaches met with little success. Now, with a better understanding of how the immune system works and with new genetic engineering techniques the immunotherapeutic approach is looking more plausible.

An immune response involves the coordinated action of an army of different blood cell types such as macrophages, T-lymphocytes, B-lymphocytes which

roam about freely in and out of the circulatory system. All these cells cooperate with each other to setup an immune defence. B-lymphocytes govern the humoral or the antibody mediated arm of the immune response. Each of these type of cells produces a specific antibody that recognises a single foreign molecule (or antigen) on the bacterium or invader. Antibodies so produced bind to the antigen bearing cell or bacterium thus marking it for destruction by other elements of the immune system.

T-lymphocytes direct what is called the cell mediated immunity and destroy foreign tissues or infected cells. Each T-cell has a receptor (a protein molecule on its surface) which recognises only a single antigen. There are different types of T lymphocytes. T-helper and T-suppressor cells modulate the immune response while the third type called T-cytotoxic cells (also called killer cells) kill abnormal cells directly. T-helper lympho-

cytes constitute the master switch of the immune response. They recognise the antigen bound with some proteins called the Major Histocompatibility complex II (MHC-II) proteins present on macrophages. All other nucleated cells have the other type of MHC proteins, MHC-I on their surface. The altered traits on the surface of malignant cells or virus infected cells are recognized by specific cytotoxic T-cells bound to MHC class I antigen protein. In contrast, B-lymphocytes and the antibodies they secrete recognise an antigen by its shape alone and do not need MHC proteins.

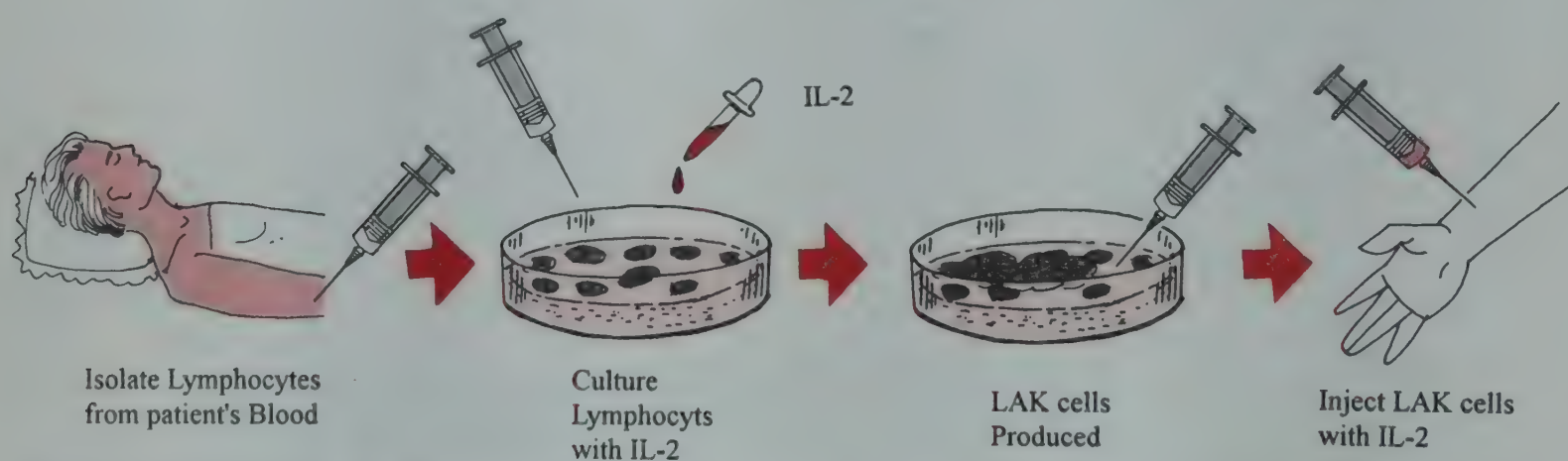
A few helper T-cells having the required receptor can bind to the antigen IL-1 (Interlukin-1 a small protein secreted by macrophages,) which stimulates them to become autonomous growth factories. The helper T-

Biotechnology

cells start secreting a hormone, the interleukin-2 (IL-2) which promotes proliferation of T-cells. The stimulated helper T-cells also secrete various other factors which activate other T-lymphocytes (cytotoxic T-cells and suppressor T-cells) and B-lymphocytes.

The major cell type responsible for the destruction of tumour cells are the cytotoxic T-cells. These cells bind to the antigen complexed with MHC class-I antigen proteins on the cancer cells and kill it on receiving the IL-2 hormone signal from helper T-cells. The killing is believed to result from the action of cytotoxic substances present in the cytotoxic T-cells. These make holes in the membrane of the target cell and thus rupture or lyse them. As IL-2 stimulates the reproduction in large numbers of specific T-cells and B-cells which have identified the antigen, it has been extensively used as an immunotherapeutic agent.

is possible to raise the immune cells reactive against tumors by repeatedly injecting the animal with tumor cells. Peter Alexander in London and Alexander Fefer of the University of Washington, in 1960, injected lymphocytes from immunised mice into the blood of tumor bearing mice. Both mice were genetically and immunologically identical so that the recipient's immune system did not consider the donor's lymphocytes as foreign and destroy them. They found that the tumor regressed or got cured. Fefer then induced lymphoma, a cancer, to form in the abdominal cavity of mice and then cured it by injecting into them T-cells obtained from other immunised mice and grown in test-tubes. When the lymphoma cells were injected into the foot pad of the mice, a tumor formed which then spread to blood and lymph nodes. Further, on injecting the cultured T-cells from immunised mice into the tumour bearing mice, the growing tumour in the foot pad disappeared as also the cancer which had spread



One way of teaching the body to fight cancer is to inject lymphokine activated killer cells. These are grown and activated outside the body and reinserted into the patient

Cell transfer therapy or adoptive immunotherapy is another of the latest techniques being used these days for the treatment of cancer. In this technique the cells involved in the immune response are removed from the cancer patient and then are either educated, that is adapted, to react against cancer, if they are not already activated or else their natural ability to kill cancer cells is enhanced so that they can be effective against a fast growing tumor. Then these cells are returned to the blood with other molecules such as interleukin-2 which stimulate their action. Fewer cells are required to be transferred with interleukin-2 as it helps in the multiplication of the transferred cells.

The main hurdle in the development of cell transfer therapy for humans is the difficulty in separating the lymphocytes activated against the cancer from the patient and growing it outside the body. In animals, it

elsewhere. This meant that cultured cells search out and find cancer cells on their own after injection into the blood stream.

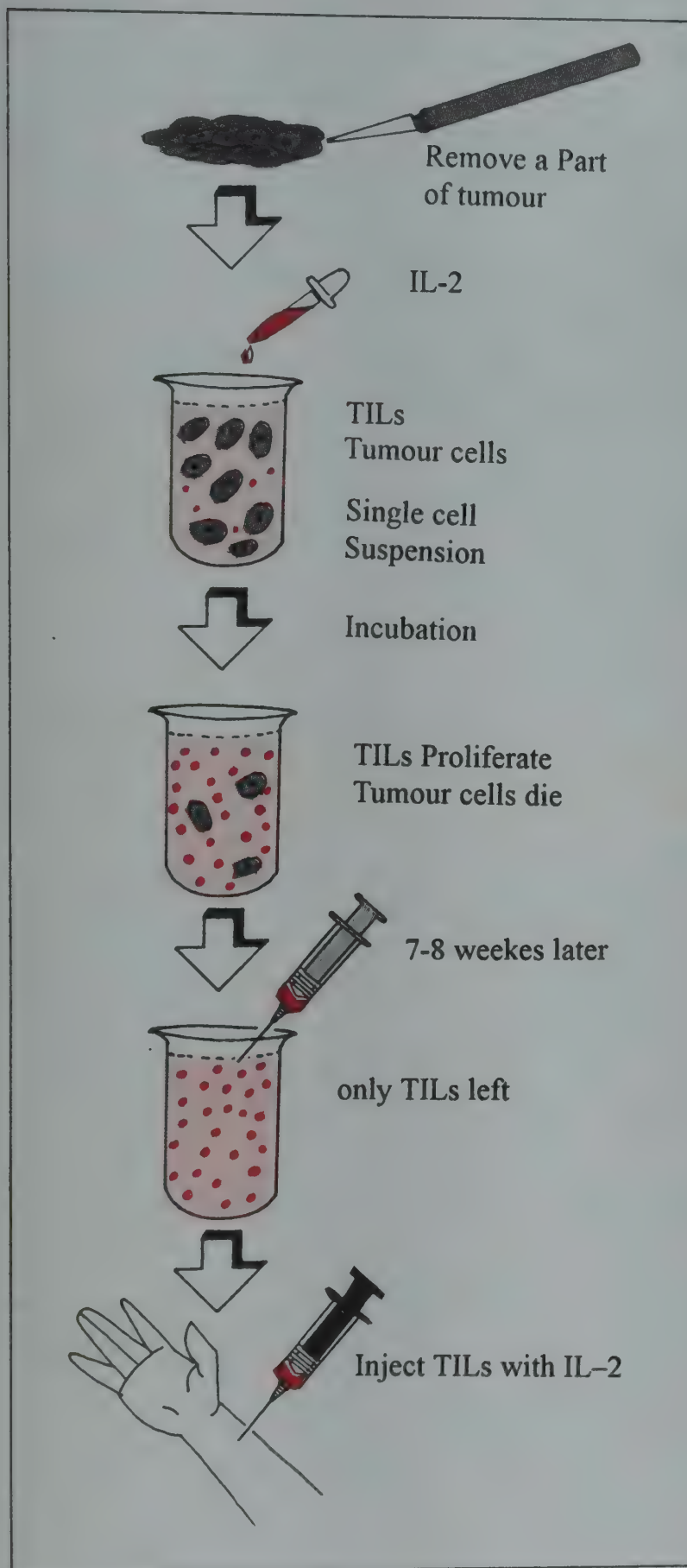
In 1976, Robert C. Gallo, an American scientist, discovered that Interleukin-2 produced by helper T-cells induces proliferation in antigen activated T helper cells and cytotoxic T-cells. With this discovery and the new methods of culturing T-cells, cell transfer therapy for humans became possible. Lymphocytes activated against patient's carcinoma are isolated, increased in number and then returned to the blood. In 1980 a new group of lymphocytes called LAK cells (lymphokine activated killer cells) were discovered. These cells are produced by incubating the lymphocytes isolated from the blood of the patient with IL-2 for prolonged periods. These cells can work against a variety of tumors and

also are not harmful to normal cells. With this discovery, now there is no need to look for lymphocytes activated against a particular patient's cancer. The LAK cells are not cytotoxic T-cells or for that matter any kind

of T-cells or B-cells though their precursors can be isolated from blood, spleen and lymphnodes. These cells appear to be part of a primitive immuno-surveillance mechanism that can eliminate cancerous or otherwise altered cells without first having to recognise a particular antigen. Though very large doses of injected IL-2 have antitumor activity (by proliferating and stimulating the specifically activated lymphocytes) the results are better when IL-2 is administered with LAK cells. LAK cells and other lymphocytes reach the tumor and under the influence of IL-2 divide there causing tumor regression.

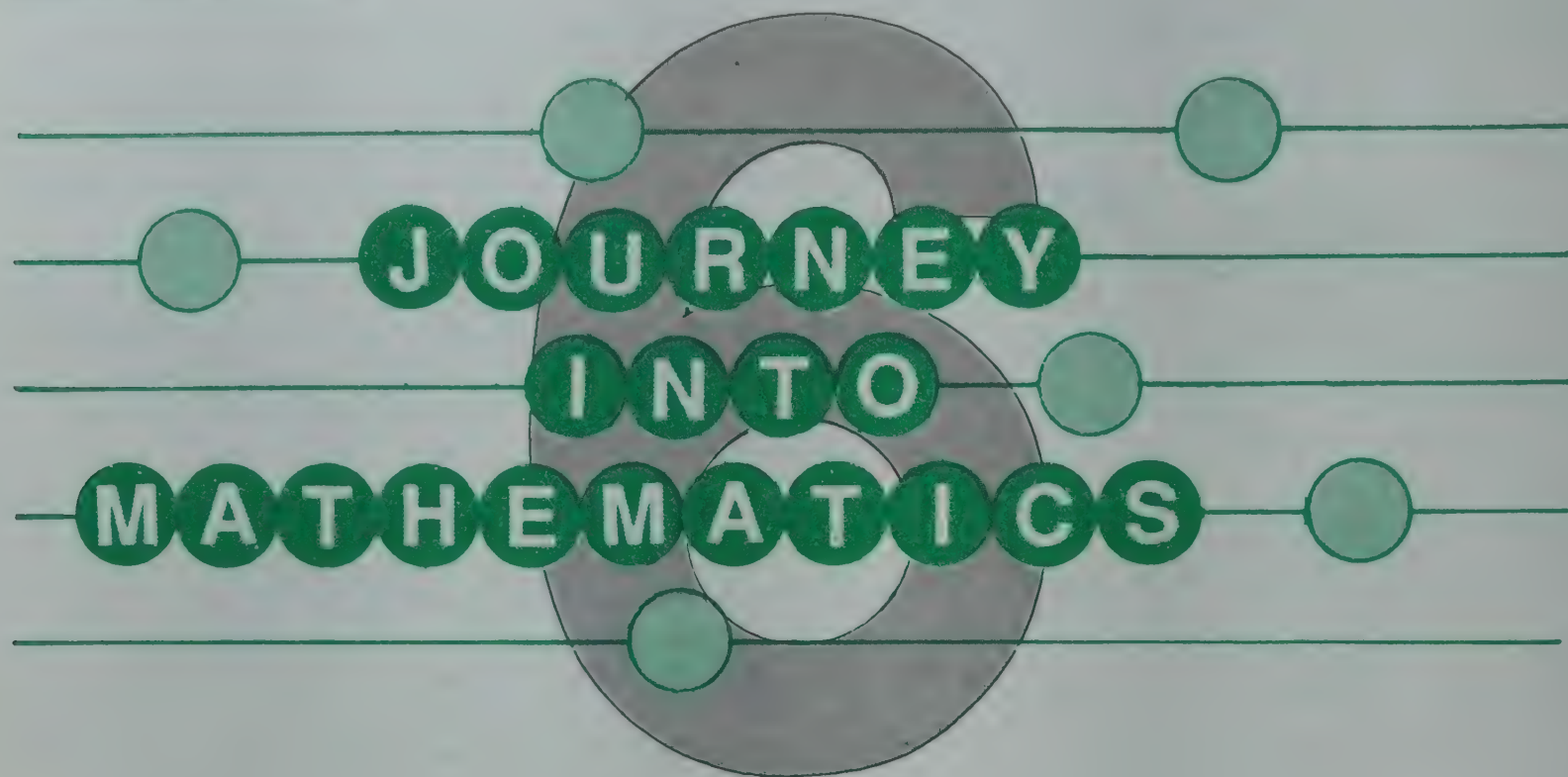
There is no doubt that lymphocytes already activated specifically by the patient's tumor are more potent against the tumor than the LAK cells. These tumour infiltrating lymphocytes also called TILs are the classic cytotoxic T cells. TILs are isolated by removing a small tumour from the patient, separating the cells and then culturing them with IL-2 for several weeks. Under the influence of IL-2, lymphocytes scattered throughout the tumor (TILs) begin to proliferate rapidly and attack the cancer cells. After a few weeks the lymphocytes in the culture completely replace the tumour cells. Then these TILs, billions of them, are injected back into the patient with additional IL-2. Studies have shown that some fraction of the cells travel to cancer sites and accumulate there in the days following TIL infusion. TILs destroy tumour cells not only by direct contact but also through production of cytokines (a type of hormones) capable of mediating cell killing.

Adaptive immunotherapy with TILs has been used on humans with a fair degree of success. Almost half of the patients treated this way have shown improvement. But that is not enough. Realizing this, many scientists are now engaged in improvising on this technique. For example, Rosenberg and his colleagues at National Cancer Institute, U.S.A are now, set upon inserting a gene such as a gene for TNF (tumor necrosis factor) or alpha - interferon or IL-2 itself into the TILs to enhance their potential. Adaptive immunotherapy is still in its infancy. Also, there are side effects but they are much less severe than those associated with any cancer drug prescribed today. Yet, what was once an intuition is now becoming a reality, and may even provide a natural way of fighting cancer.



Tumour infiltrating lymphocytes help in combating cancer

Dr (Mrs) Kushal is a Reader of Biochemistry, Deshbandhu College, University of Delhi, Kalkaji, New Delhi-110 019



True Or False

NAKUL PARASHAR

MATHEMATICS started getting tougher and a hard nut to crack. Simple calculations or jugglery of numbers no longer captivated a layman's interest. Playing mathematical games with matchsticks started to lose charm. People gradually started moving away from mathematics. Mathematicians got concerned. They began their crusade to simplify and make it understandable. This was the scene in the early nineteenth century. It is then that mathematicians and physicists thought of an even more exact science-propositional calculus, to keep human mind in good humour.

Any simple declarative sentence like "Elephants have Wings" or "dynamite is dangerous" or "Columbus discovered America" are called propositions. These propositions are either true or false. Finding which one is it, is the discovery of valid arguments

about the propositions.

Now, let us consider a compound proposition: If either Sita loves flowers (A) or Ramesh is left-handed (B) and Ramesh is not left-handed, then Sita loves flowers. What a silly proposition, isn't it? But it is logical and indeed a special case of the following more respectable sounding general proposition.

This compound proposition, which is true independent of the truth or falsity of the propositions (A) and (B), is called a theorem of the propositional calculus. It represents a universally valid way of drawing a certain *conclusion* (A is true) from certain *premise* (either A or B is true, B not true). Of course, not every proposition is a *theorem*. For example consider the following proposition :

If P is true, then Q is true; if Q is false, then R is true; R is False; therefore P is true.

This argument sounds impressive, but as we shall see later it is not logically correct. In other words this compound proposition is not a theorem. The propositional calculus gives us a foolproof procedure for deciding whether or not any given proposition, however complicated it may be, is a theorem and for producing new theorems.

Before we sail ahead to prove theorems, we need to know some standard formal notations which we'll be using to express the complex propositions like the one we just discarded as not logically correct. There are five simple basic notations which are also called connectives. They are and (\wedge), or (\vee), nor (\sim), implies (\rightarrow) and if and only if (\leftrightarrow). If a compound proposition "Sita loves flowers and Columbus discovered America" is built from propositions A and C, then it is denoted as ($A \wedge C$). Similarly for "either A is true,

or B is true, or both", the symbolic representation would be $(A \vee B)$. The symbol for negation of proposition is \sim . Thus, the proposition "Dynamite is not dangerous" would be represented by $\sim D$. An if-then type of proposition uses the symbol \rightarrow . For example "If Elephants have wings (E), then Batman is lefthanded (B)" would be written as $(E \rightarrow B)$. Finally, the connective *if and only if* which is depicted by \leftrightarrow can be represented by the following proposition - "Dynamite is dangerous (D) if and only if Sita loves flowers (S)", which is written as $(D \leftrightarrow S)$. The alphabetical representations of the propositions are called atomic propositions which help a lot in not only saving paper but also the time used in solving complex propositional problems. Unlike the elements of a set the atoms need not be bound within parentheses.

The five notations when followed in a strict sequence constitute, what is called a *well-formed proposition* (WFP)

or in other words propositions that are formed by successive application of the following rules:

1. Variables like A,B,C,... are called WFPs called atoms. If X and Y are WFPs, then so are each of the following :

2. $(X \wedge Y)$
3. $(X \vee Y)$
4. $\sim X$
5. $(X \rightarrow Y)$
6. $(X \leftrightarrow Y)$

Now, that we know how to form WFPs, we can reverse the process and learn how to recognize them. Consider for example, a very complex proposition like the one here.

$$((\sim(A \wedge B) \vee C) \rightarrow \sim A)$$

To dissect it, we use a technique called parsing (See below). Parsing is used exclusively in designing various types of high level complex computer language compilers. As a first step we replace atoms A,B and C by " $*$ ". We do this because according to rule 1 of the WFP game, every atom is a WFP

and " $*$ " is a symbol we use to represent "a well formed proposition". If we now scan line 2, we see two "sub-propositions" that are themselves WFPs, that is, " $(* \wedge *)$ " and $\sim *$

line 1 $((\sim(A \wedge B) \vee C) \rightarrow \sim A)$

line 2 $((\sim(* \wedge *) \vee *) \rightarrow \sim *)$

line 3 $((\sim * \vee *) \rightarrow *)$

line 4 $((* \vee *) \rightarrow *)$

line 5 $(* \rightarrow *)$

line 6 $*$

The first one is well formed by rule 2, and the second one follows the rule 4. Thus, in line 3 we find the WFP " $\sim *$ ", which is replaced in the subsequent line by " $*$ ". Continuing so, we finally reach a stage where the entire complicated proposition has compacted to a mere " $*$ ", which means its a well formed proposition.

Thus, after having seen what a WFP is, lets proceed to our real destination, the discovery of valid arguments and theorems in the propositional calculus. True or false is only what a well declarative sentence or proposition can hold. Now, let us see how these WFPs alongwith the connectives behave when these propositions are originally true or false. In other words, what is the outcome if two separate atoms of a proposition holding true values have a *if and only if* connective. The answer is a set of tables called the truth tables. To be more clear let us take an example of two WFPs X and Y. The *and* (\wedge) connected proposition of these two WFP would be true if and only if X and Y are true.



For The Young

X	Y	$(X \wedge Y)$
T	T	T
T	F	F
F	T	F
F	F	F

and

X	Y	$(X \vee Y)$
T	T	T
T	F	T
F	T	T
F	F	T

or

X	$\sim X$
T	F
F	T

not

Y	$\sim Y$
T	F
F	T

not

X	Y	$X \rightarrow Y$
T	T	T
T	F	F
F	T	T
F	F	T

implies

X	Y	$X \leftrightarrow Y$
T	T	T
T	F	F
F	T	F
F	F	T

if and only if

Truth tables for five propositional connectives

In these five propositional connectives " \rightarrow " (*implies*) is an important connective. In a complex proposition like $((A \vee B) \wedge \sim B) \rightarrow A$ the truth table takes the following form.

Here, the first four columns are called the premise and the fifth, the conclusion. In such a case where all

A	B	$(A \vee B)$	$(\sim B)$	$((A \vee B) \wedge \sim B)$	$((A \vee B) \wedge \sim B) \rightarrow A$
T	T	T	F	F	T
T	F	T	T	T	T
F	T	T	F	F	T
F	F	F	T	F	T

I

II

III

IV

V

the possible truth values for A and B have truth value for the conclusion, the proposition is called a *theorem* of the propositional calculus or tautology.

In fact, this decision procedure is completely mechanical, and could be stated in the form of a computer algorithm. Thus, the propositional calculus is one branch of mathematics

where to prove a theorem one need not exercise his mind much. Unfortunately, this is only said and not practised. As no theorem-proving algorithm exists in any all branch of useful mathematics.

This remarkable discovery was made in 1936 by *Alonzo Church* and independently by *Alan Turing*, of the famous Turing machines. Such an attempt made by nineteenth century, mathematicians to make pure maths an exact science was remarkable indeed. It also prompted *George Boole* to put forward his Boolean mathematics.

Shri Parashar is a scientist with the Publications and Information Directorate, C.S.I.R., Dr K.S. Krishnan Marg, New Delhi-110012

TAMING TOUGH TERRAINS (Continued from page 16)

be judged by the fact that at times, as much as 30,000 cubic metres of snow may have to be cleared in a single kilometer of road. Such action is seen routinely in the world's highest altitude motorable road that goes over high passes like Zojila in Ladakh.

Technological innovation, we were told, is a continuing activity of the BRO. In Mizoram "bitumen emulsions are being experimented with for black topping, possibly these may work well" said L.M. Verma, Chief Engineer, Project Pushpak. (See Box: Roads Go Green). The BRO has developed a simple, cheap and effective steel decking for Bailey and Hamilton bridges which replaces timber earlier

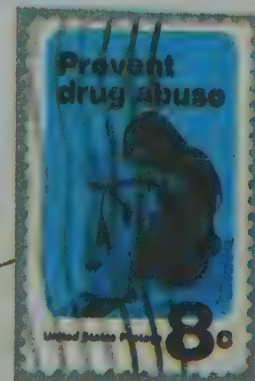
used for roadway decking. Known as "GREF modification" it has led to a recurring annual saving of nearly Rs 75 lakh in timber replacement costs. For bulldozers working in subzero temperature, a GREF workshop has devised a new radiator muff which enables the machine to attain working temperature in just 10 minutes as against usual 45 min., thus saving substantial machine life and fuel as well.

A unique feature of the BRO is that it executes the entire road construction work, beginning with the initial reconnaissance to the final black topping, by itself; it does not award civil contracts to other agencies. This is done "to ensure quality and completion of projects in time" said Brigadier S.B. Joshi, Deputy Director General, Border Roads Organisation. Difference in quality was easily discernible

as we drove along stretches of GREF roads and roads built by PWD in Rajasthan.

Today, BRO is no longer a mere road building organization. The expertise of its engineers are now being increasingly utilized for other civil construction activities including construction of major canals, hydel works, airport runways and even buildings. It has already completed upgradation of the Paro airfield in Bhutan and has taken up the expansion work on the civil airfield at Dibrugarh. However, road building and maintenance remains to be the mainstay of BRO. Their efficient work ethics is best reflected by the following slogan seen at Project Chetak:

"Better roads make people happy.
Happy people make better roads". □



BEWARE OF DRUGS

KABITA ROY

THE problem related to narcotic consumption all over the world has been concerning all of us.

The psychotropic drugs (also called narcotics) act on the brain resulting in changed behaviour. The psychotropic drugs can be classified into three types: the ones that stimulate the central nervous system, like cocaine and the amphetamines existing in the appetite moderators; the ones that depress the central nervous system such as solvents (shoemaker's glue type), tranquillizers or sedatives, and alcohol; and the ones that disturb the functioning of the brain, among which marijuana and LSD are included. The increase in its use among the population, especially the youth has resulted in numerous social problems. This is also true for developing nations, including India, where the problem is not confined to any particular group or section of society.

The problem has now reached

epidemic proportions. To combat this problem of drug abuse various plans have been drawn. One of them is to prevent the spread of drug abuse by building awareness and educating the people about its bad effects; secondly by dealing with drug addicts through a well founded programme of motivation, counselling, treatment and rehabilitation; and thirdly, by curbing illicit trafficking in drugs within the country and across the borders. To put up a concerted fight against this

plague in our society, to draw attention and to arouse interest in eliminating the malaise, many countries released special stamps.

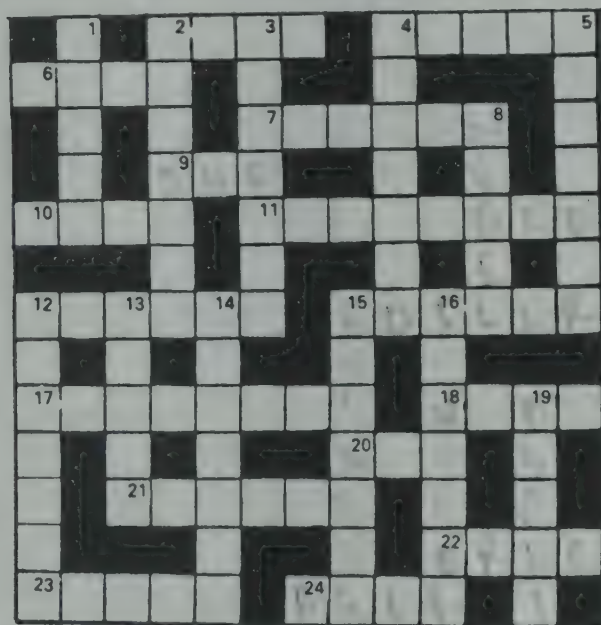
Issued on July 7, 1988 the Hungarian stamp represents a stylized human head in a dark green background referring to the effect of narcotics. Next to the design, on the left side, there is a vertical inscription: "Let us fight against narcotics and drugs!". On the Brazil's stamp (issued on April 7, 1991), the artist has conceived the Fight against Drugs in a lofty sense of "campaign" by using a graphic composition with pictograph of international understanding where a symbol of denial - the "X" - appears in red colour over the visual representation. The USA, Pakistan and Philippines also issued stamps in recognition of the campaign against drugs with the principal slogan "Fight Drug Abuse". On March 5, 1991 India also released a five rupees stamp featuring the vice of drug abuse.

CROSSWORD

VIJAYA KHANDURIE

ACROSS

2. Richard _____ whose studies on carotenoids and vitamins won him the Nobel Prize in 1938 (4)
4. Unicellular protozoan or coccus (5)
6. Surname of Indian Plant expert who invented crescograph (4)
7. Thomas Hunt _____ whose discoveries on hereditary function of the chromosomes earned him the Nobel Prize in 1933 (6)
9. A unique number which is the square of itself (3)
10. A manoeuvre in which an airplane descends along a spiral path (4)
11. Ground over which a river flows (8)
12. Contraction of the pupil of the eye (6)
15. A pressure vessel in which water is heated and then discharged (6).
17. It is designated by either of the letters s,p,d,f (3-5)
18. Cylindrical part of a gamosepalous calyx (4)



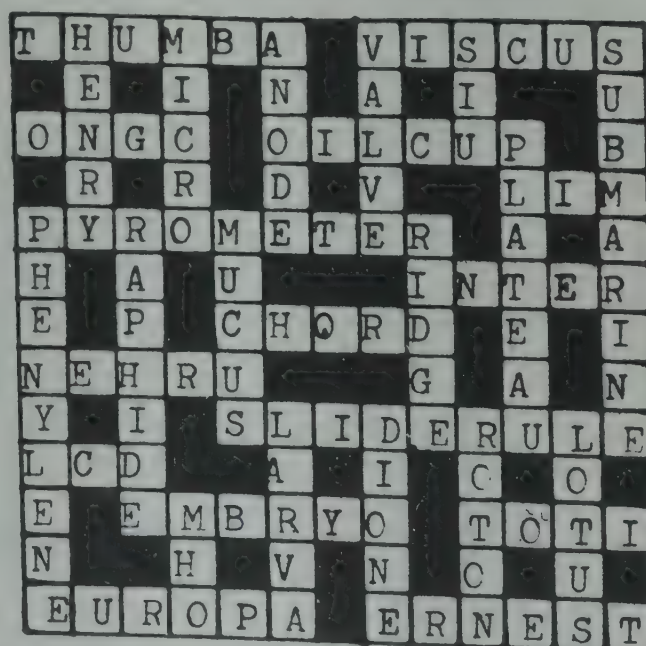
DOWN

1. A dried hydrophilic substance extracted from species of red algae (5)
2. Compounds containing a carbonyl group in the molecule attached to two hydrocarbon radicals (7)
3. The bone of the upper-arm (7)
4. Electric generator capable of producing high voltage impulses (7)
5. That part of the T.V. receiver which separates the incoming colour information into the primary colour components (7)
8. Surname of the Swedish engineer who invented dynamite (5)
12. Semi-wild horse of the North American plains (7)
13. Path of a space vehicle moving about the Earth (5)
14. Egyptian physician born c.3000 B.C. who was revered as god of medicine (7)
15. Variety of dog, very courageous and powerful with a large head and a short thick neck (6)
16. The set {...-3,-2,-1,0,1,2,3,...} (7)
19. Acronym for a computer language (5)

(Solution in the next issue)

20. Strong solution of sodium or potassium hydroxide (3)
21. The four haploid cells formed at the end of meiosis (6)
22. _____ von Behring, German scientist, the first one to be awarded the Nobel Prize for Medicine or Physiology (4)
23. A vertical column of the periodic table containing elements of similar properties (5)
24. _____ agar; Polysaccharide obtained from sea-weed, used in culture of micro-organisms (4)

Solution to November Crossword



Shri Khandurie is a science educationist. Address: 23-L, Sector IV, D.I.Z. Area, Shahid Bhagat Singh Marg, New Delhi-110 001

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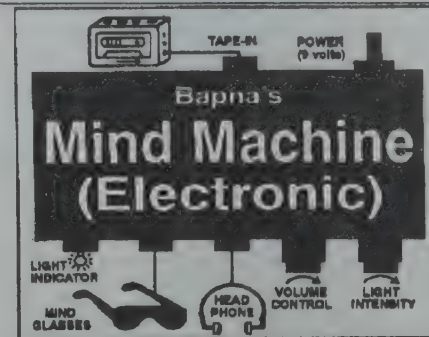
tion, hearing, RAGA ANIL, imagination, Hidden-Messages, etc.

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• Your music is very effective.

—A. V. S. Satish, class XII student

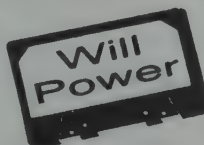
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—Rajasthan Patrika Book/Music Review

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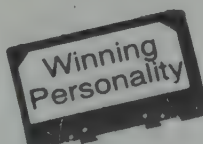
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Antenna

IF there is anything under the sun that is intimate at the same time enigmatic to the human-kind, it is the environment. In these days of intensive green movements this statement may seem an exaggeration, but the complex nature of issues related to environment make it a subject very difficult to understand. That was one of the reasons why we waited, with invitation on hand, for the inauguration of "Terre! Terre!" — an interactive science exhibition on environment organised by the French embassy at Alliance Francaise, New Delhi from 22nd October 1993 to the



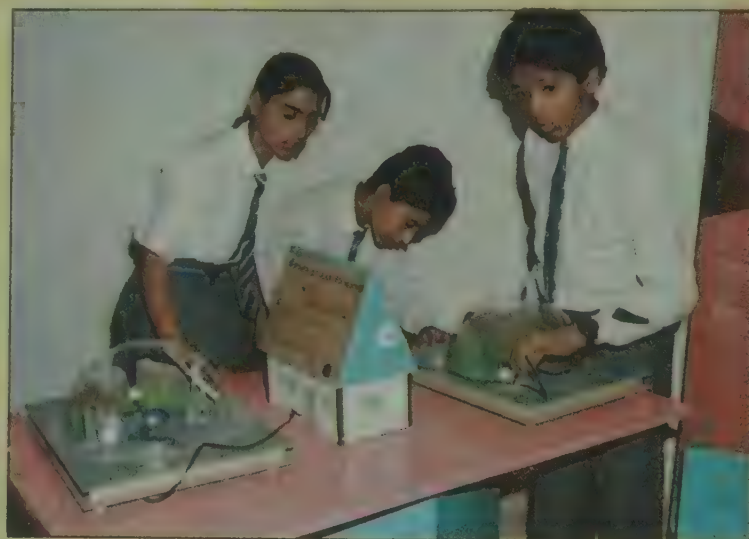
5th of November, 1993. There was another reason for our curiosity. A previous encounter two years ago with a similar exhibition on biotechnology — the BIOPOP. It was a travelling classroom consisting of a few good, innovative, interactive exhibits. That 'Terre! Terre!' also came from the same City of Science and Industry in France pulled us to the exhibition. We were also curious to know how the different aspects of environment, such as the weather phenomenon, pollution, ozone depletion, water budget—all of them complex and interrelated topics—were dealt with in the exhibition. It is not easy to design an interactive exhibit that would catch the eye of

the visitors, invite them to play, teach some basics and prod them to explore further.

"Terre! Terre!" like its predecessor BIOPOP is an assemblage of some twenty interactive exhibits, all of them low-cost, yet innovative exhibits. Each exhibit is displayed along with a beautifully illustrated poster which announces, in French and in English, the topic to which the exhibit is related. Beside the exhibit is a leading question, a question that raises more questions in your mind and leads you to better un-

wind, ecological balances, natural carbon and water cycles, soil and its importance and so on.

The interactive exhibits are quite innovative in that they use a toy — at times a well known one — or games to lead you to a question and leave you to probe further. All toys and games



Terre

TALKING ABOUT

derstanding. The best part of the exhibition is that it is portable and all the exhibits can be easily packed in a large carton and carried.

The topics which the exhibition asks the visitors to probe deeply into are quite varied too. There is an exhibit on the various sources of energy and one on ecological pyramid (or food chains). There is one on atmosphere, telling us of its extent, pressure and contents with the help of just a vacuum pump and a bell-jar. There are exhibits which lead you to weather phenomenon,



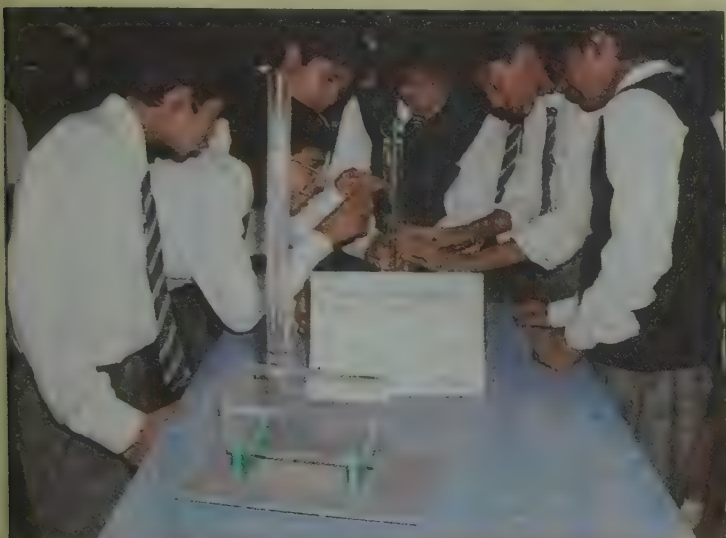
are simple constructions and low-cost too. For example, there is an exhibit on a board in which some twenty pieces of wood are placed. The placard by the side asks you how familiar you are with different types of timber

wood and challenges you to identify the twenty. If you have done that and want to make sure about your identification just lift the piece of wood, note the number underneath and tally it with the table written alongside. A simple game, no doubt, but it will show you how ignorant you may be.

you do not have some basic knowledge of the interaction between animals and plants. The game of food-chain or food pyramic asks you to select pictures of animals and plants, bound in a circular perspex disc, and pile up one disc over another inside a triangle on a board. There is a condition going with the game: The animal or plant in the upper disc should always be using the one in the lower box as food. Can you fill up the triangle with these pictures? It looks simple only if you know the food habits of a lot of animals. For instance, does the bear eat rabbits or wolf? Well, that is how the game of learning should be, teasing.

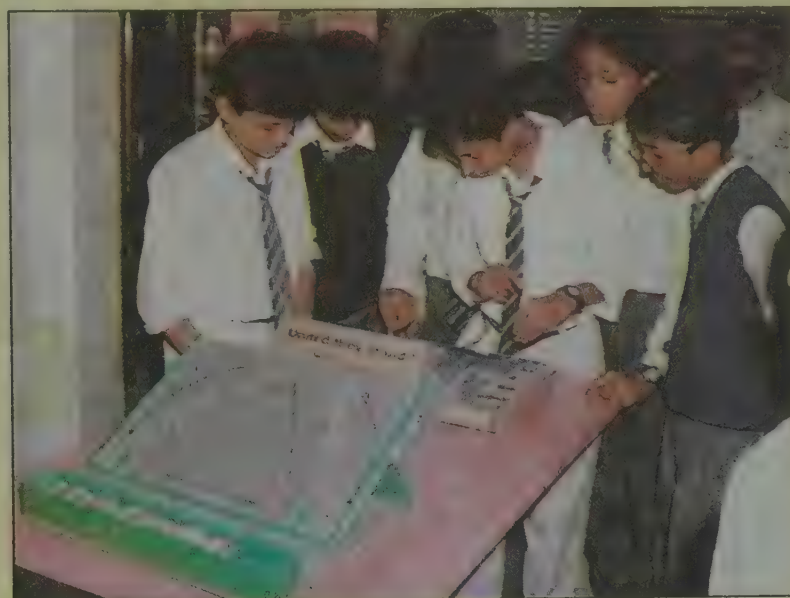
exhibit trying to arrange the circular discs along the edges of the triangle and failing each time. She never understood the clue, nor did she look like having some basic knowledge about ecology. There were no guides to tell her how to play with it and learn. There is certainly the need for a guide or teacher to be present to understand the exhibits well. However, Terre! Terre! has another failing too. Some of the exhibits have directions written only in French which is Greek to most Indians.

Terre! Terre! will be taken around the country, to all those places where an Alliance Francaise link exists. It will finally land up, following the



Terre

THE EARTH



At Terre! Terre! we found the first of our expectations, that it could be a good laboratory for teachers to tell their pupils about the complex subject of environment come true. So did our other expectation, nay fear, that inspite of being good the exhibition may fail. An interactive

exhibit, howsoever good, often

fails if the visitor is not interested in the subject or if there is nobody to tell visitors how to play with the toy. At Terre! Terre! for example, we saw a visitor play with the food-pyramid

foot steps of BIOPOP, as a permanent exhibit at the Birla Planetarium, Hyderabad. If you have a large hall to spare, access to electricity and good intentions, try arranging an exhibition at your town. For details, contact B. G. Siddarth, Director, Birla Planetarium, Hyderabad or The Office of The Director, CEDUST, French Embassy, 2, Aurangzeb Road, New Delhi-11. One last word, don't forget to get the French instructions translated into the local lingo for better communication.

Certainly you will look closer and try to understand the differences between the various types of woods.

There is another simpler game but which turns out to be frustrating if

Photographs: Courtesy CEDUST, French Embassy, New Delhi

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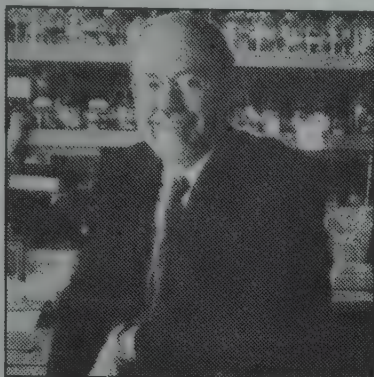
NOBEL PRIZES—1993

(Continued from page 41)

The genes of higher organisms were assumed to have the same structure and function as that of bacterial genes until Robert and Sharp shook the scientific world with their spectacular results. Contrary to the existing belief, the two scientists showed that the



Roberts



Sharp

genes of higher animals are fragmented in structure as they exist in several pieces separated from each other by long stretches of non-coding sequences, commonly called 'junk' DNA. The coding units of the gene were later called 'exons' and the interrupting DNA sequences 'introns'. Depending on the size of the gene, the number and length of exons may vary from a few to more than fifty exons interspersed with stretches of DNA that contain no genetic information. This is in sharp contrast with the bacterial genes which contain no introns.

These so-called 'split genes' in higher organisms were discovered by Robert and Sharp while studying the genetic material of Adenoviruses — a group of viruses that cause common cold and pink eye (conjunctivitis). They chose this study material as adenoviruses use the machinery of eukaryotic cells to grow and multiply. Hence, what is applicable to viral protein synthesis would also stand true in case of the cells they infect. To study the relationship between the viral genome and the mRNA molecules which carry its genetic message, the two scientists, working independently, made these messenger molecules hybridize with their pro-

genitor, the DNA segments of the virus. Wherever the mRNA found a complimentary sequence on the single-stranded DNA molecule, it got bound to it or hybridized. The hybrid molecules of mRNA-DNA complex so generated were then visualized on electron microscope to observe which part of the viral genome had produced the mRNA strand. Unexpected as it was, the mRNA strands did not hybridize with the DNA linearly but showed a discontinuous pattern. Huge loops of unpaired DNA, between the hybrid complexes, clearly revealed that large chunks of the DNA strand carry no ge-

netic message and hence take no part in protein synthesis. The mRNA molecule of the Adenovirus was shown to correspond to four different regions of the DNA encoding it.

However, during the synthesis of mRNA, the junk DNA also gets copied along with the actual genetic message. On processing this precursor mRNA molecule, the interspersing sequences are clipped out and subsequently stitched together or the coding regions spliced. This now gives rise to a complete, functional string of genetic instructions or a mature mRNA molecule. Thus, the latter is a much trimmed version of the original, precursor mRNA molecule. This now directs the cellular machinery to construct a protein.

With the above insight, a lot of scientific data hitherto puzzling and inexplicable soon began to make sense. For example, why the nuclei of eukaryotic cells have such long threads of RNA now became clear. The discontinuous gene structure was later to be true in most higher organisms, including man.

Based on errors in the splicing process, the origin of several inherited diseases and cancers has now become clear. For example, in one inherited

disorder, known as 'Thalassaemia', a genetic alteration or mutation arising as a result of splicing error has been recognised. Errors in processing of the precursor mRNA have been also shown to cause cancers, like chronic myeloid leukaemia. What's more, a slightest error in this process has a potential danger of transforming normal genes into cancer-causing genes called oncogenes.

But why did nature choose this structure of genes in higher organisms? A plausible reason for this is to be able to arrange in different ways the several exons that make up that gene. In this way, different protein molecules can be generated from the parent gene, thus making genetic material creative and more flexible. It also explains how genes evolve over time. Based on Roberts' and Sharp's theory, Walter Gilbert, a Harvard biologist proposed the concept of 'exon shuffling' which describes the evolutionary development of genes. It suggests that if several exons from different sources are brought together, novel combinations may occur producing new genetic sequences, coding for new proteins. Gene evolution due to exon shuffling is a much faster process than the slow accumulation of a long series of mutations in a gene which cause only minor alterations.

Split genes, nevertheless raise an intriguing query of the origin of non-coding sequences that intersperse the exons. Some scientists surmise that they were trimmed out of simple organisms in view of molecular simplicity. A few even go on to believe that intron sequences are but a molecular parasite which had infected cells of higher organisms while sparing those of simpler ones. However, a different view is held by some scientists. They believe that introns are not just junk DNA but it contains some regulatory signals hidden within them which control the synthesis of proteins. This argument on the origin of intron, however, goes on.

Parvinder Chawla

Nobel Prizes

SELDOM do I find such rare sights. Sitting on the stone bench beside the lake on the outskirts of my home town my hometown and watching the setting sun is one of my favourite hobbies. Along the bund of this lake are planted several flowering trees which sway at the cool breeze blowing along the lake. It is quite an enchanting moment to sit there in quietitude and listen to the calls of birds. The flowering trees present there add to this serenity. The trees have been so chosen that one or the other of them will be flowering on any visit to the lake. When I visited the lake some weeks ago, some of the tall trees were in bloom generously showering their annual produce. The ground below the trees was a white fluffy carpet because of the fallen flowers. The flowers were long, slender and pure white in colour, giving out a mild fragrance.

These flowers whose sight was quite charming were of the Indian Cork tree which is also popular as the Tube Rose tree owing to the resemblance of its flowers to Tube rose, a cut flower. Being one of the best flowering trees of India, it is seen in parks, along the avenues and also in plantations. It is a large tree often



Marvellous Millingtonia

B. S. SOMASHEKHAR

reaching a height of 30 metres. The tree grows ramrod straight with a prominent trunk and numerous branches. These branches are slender and often droop down which often makes the tree seem as if it has been struck by some disease. This peculiar shaped canopy is called as a "weeping canopy". The leaves are compound and resemble those of the neem. The stem is rough and appears split with corky peelings.

Indian Cork tree is one of the widely seen flowering trees in India



growing in gardens and parks. It is not only beautiful to look at, but is also economically important for its soft wood timber. It is a member of the family Bignoniaceae which also includes many popular flowering trees like *Tabebuia*, *Tecoma* and *Jacaranda*. Botanists name it *Millingtonia hortensis*. Millingtonia has many ver-

naular names. In Hindi, Marathi and Bengali it has similar names — *Akas neem*, *Mini chambeli* and *Neem chambeli*. In Oriya it is called *Bakeni* and *Sita hara*. In Kannada it is known as *Akash mallige* while its names in Tamil are *Mara malli* and *Kattu malli*. In Telugu and Malayalam it is known by the names *Kavuka* and *Katesam*.

Millingtonia is preferred in the gardens for its straight growth and attractive flowers. Flowerers appear in terminal panicles. Petals are 4-5 in

number and fused along the base making the tube. At the tip, petals open as small lip like structures. Style and anthers are filament like, protruding out of the flowers. Soon after opening, the flower tube gets detached from the sepal cup and hangs on the panicle. Such hanging flower tubes look like pendant ear drops of a lady. At a later stage these detached flower tubes fall to the ground turning it into a soft carpet. A grown up tree of Millingtonia comes into bloom twice a year—the prominent flush will be during

August-September; the other flush will be during March-April. During these months the entire tree slowly gets into flowering phase. Amidst the green foliage, at the tip of the slender branchlets, the buds take shape. Soon, flowers appear and the entire tree gains an attention because of its mass flowering.

In any plant flowering is followed by fruiting. However, Millingtonia trees in India give fruits very rarely. This is mainly because of the prevailing climatic conditions. However, the fruits are long slender and are of the size of cowpea pods. The pods are slightly flattened and split open on ripening. Seeds are small, compressed flat and have papery appendages (wings) which help in their dispersal.

Millingtonia is equally good in its medicinal properties. Its wood is one of the best soft woods. The wood is mainly used for making toys and in other craft works. The bark contains small amounts of a bitter substance and tannins which are used in traditional medicinal system against fever.

Since the seeds are rarely available, the root cuttings, or the suckers available around a grown up tree are usually used for propagating. Millingtonia can be grown only in large gardens. It is put either along the garden walk or in groups in the lawn with other trees. One year old suckers are usually used as the planting material. In the desired site a cubic pit of about a metre dimension is dug and filled with a mixture of equal amounts of soil, manure and sand. The sucker is planted in the pit during the rains. Since the plant cannot tolerate strong winds in early days, a proper stake and wind break has to be provided until the plant gets well established. Millingtonia raised from the suckers will start flowering from the third year. Then it makes a good and memorable walk on a evening along the avenue lined with flowering Millingtonia.

Shri Somashekhar is a horticulturist and researcher in ecology. Address : No. 36, Niranjana Nilaya, V Cross, Opposite Government College, Tumkur-572 102

Stimulating Music

LISTEN, Manufacturers of walkmans and Karaoke Stereo-Players ! There is some news in a recent issue of the international science journal, *Nature*, (Vol. 365, Pp 611, 1993) that is music to your ears. A communication from Gordon L. Shaw and colleagues of the Centre for the Neurobiology of Learning and Memory, University of California, U.S.A. says that music may be stimulating to not only depressed moods but also the tired intellect. In a study on some three dozen college students Shaw's team tried to find whether there was any truth in the belief that listening to good tunes will also tune our minds. The students were made to listen for ten minutes to the maestro Mozart, and then asked to recognize and compare intricate patterns as well as

fold and cut papers — all standard tests for mathematical ability and reasoning. Sometimes they were also tested after just a relaxation or quietitude. Surprise of all, the students fared better in the tests that followed listening to the Mozart. In the other two conditions their responses were not any better than the usual. Shaw's team believes it to be purely due to music. Unfortunately, the intellect elevating effect lasted for only a short while after listening to Mozart and disappeared soon. Could that mean MJ can also be counted to raise your mathematical ability ? Well, the answer now is only speculative. Neither do Shaw's result vouch for *Bhajans* and the like to induce same kind of effects.

Enter The TB The Gene-Way

DESPITE efforts for more than a century Man is still to end his fight against tuberculosis. Tuberculosis — or TB for short, caused by an infective bacteria the *Mycobacterium tuberculosis* is one of the dangerous pestilence that debilitates and kills millions of people around the globe every year. The bacterium had had an upper hand in the battle because it takes refuge inside macrophages, a type of blood cells which fight the war for the body. No wonder, scientists have always dreamt of finding the key to this successful strategy of the pathogen and use it to beat the disease into a defeat. A report published in *Science* (Vol. 261, Pp 1454-1457, 1993) by a team of scientists at the Division of International Medicine, Cornell University Medical college, New York, U.S.A. led by Lee. W. Riley seems to have latched on to such a key. Riley and colleagues

have homed in on a 1535 base long gene in the bacterium which seems to help it to sneak in to the fighter cell macrophage. To confirm its function Riley's team also tested the gene in *Escherichia Coli*, a bacteria which cannot on its own get inside any cell. They found that *E.coli* could easily get inside *HeLa* cells (a mammalian cell type very commonly used in laboratories) if it carried the bit of gene from *Mycobacterium tuberculosis*. Such *E.coli* showed a clear sheath around their body when viewed under electron microscope. This covering called electron transparent zone, a hall-mark of *Mycobacterium tuberculosis* is considered as an indicator of the bacteria's ability to stay put inside macrophages. Riley's team believes that the survival inside macrophages of the TB is due to the synthesis of a short protein.



How Cold Is Pluto ?

PLUTO, the last member of the Sun-family of planets still remains an enigma. Not much is known about the atmosphere on the planet Pluto which is some 58,736,000,000 kilometres from sun. For one thing, it is certain that the planet is quite cold. But how freezing is it is still a matter of conjecture. In a research paper published in *Science*, (Vol. 261, Pp 1713-1716, 1993) S. Alan Stern and colleagues at Space Sciences Department, South West Research Institute, San Antonio, Texas, U.S.A. say that Pluto can be as cold as 25 to 40 Kelvins at its surface. That is some tens of degrees well below the temperature of liquid nitrogen. Stern's team studied the distant member using highly sophisticated equipment that could read even millimetrewave thermal emissions (low level heat radiations) coming from Pluto. Their conclusions could change many other beliefs about Pluto too. Such a colder surface means that its atmosphere cannot have methane gas as a major constituent, as is presently believed. The clues seen in spectra of Pluto for the presence of methane, as a thin dark line, may be caused by the gas frozen on Pluto's surface. Pluto, Stern's team contends, may have an atmosphere made up with chiefly of nitrogen and carbon monoxide with just traces of methane added.

Turning Bitterness Into Sweet

THE most detested taste, the bitter taste, may turn sweet if the plans of a Japanese team of scientists comes to fruition. Y. Katsuragi and Kurihara, K. have prepared a powder which can suppress the bitterness of many a chemical. The powder contains phosphatidic acid and beta-lactoglobulin two chemicals well known as antagonists of bitter taste. Both, of which when separate, do not dissolve in water. This had made it difficult to put to good use their bitterness masking abilities. However, Katsuragi and Kurihara have, through some chemical jugglery, succeeded in preparing a soluble powder of the chemicals in a combined form. They contend that the powder can suppress bitter taste of some eight well known substances such as caffeine (found in coffee) papavarine (poppy seeds), isoleucine (found in many bitter substances) and does not affect the salty taste. Does it mean days of less sugar in stronger coffee are near? One only has to wait to taste the real thing ! (*Nature*, Vol. 345, Pp 213, 1993)

Reading A Diamond

WELL, crystal gazing may or may not help you to know the future, but gazing at diamond with sophisticated instruments can at times provide insight into deep mysteries of earth. One such mystery about which a diamond has revealed much is the behaviour of the bowels of earth. As everyone is told so many times, the inwards of green planet is filled with nothing but hot rock - molten at the deepest parts and solid at the top. But what remains a mystery is whether the two layers known to scientists as upper mantle and lower mantle ever get mixed by the silent boiling that occurs forever there. There have been many opinions in this regard. But Ben Harte and Jeffrey Harris, two British minerologists, say that the two layers often get mixed up evidence for which can be found in diamonds which are mined from deep earth. A recent study on one such unusual diamond mined in Brazil has the proof as impurities in it. The diamond got from mines near Sao Luis, has impurities like the mineral ferropericlasite magnesiowustite and calcium silicate. These minerals which are believed to be found only at the lower mantle are seen in the diamond along with magnesium silicate (enstatite) a mineral believed to occur only in upper mantles. With such a proof, Harte and Harris contend that the diamond must have formed some 660 kilometres below the surface and pushed up by the boiling of hot molten rocks. There is more to the glitter of a diamond isn't it ?

GAS

V. MEMURI

AM I still going to be read after writing this subject? No, I am not talking about the stuff you put in your cars. Sorry, it is not even the stuff you use for cooking. "Passing gas" is certainly embarrassing, because it is universally an uncomfortable subject. Having the courage to talk about it is not a laughing matter either. Let us talk about it anyway.

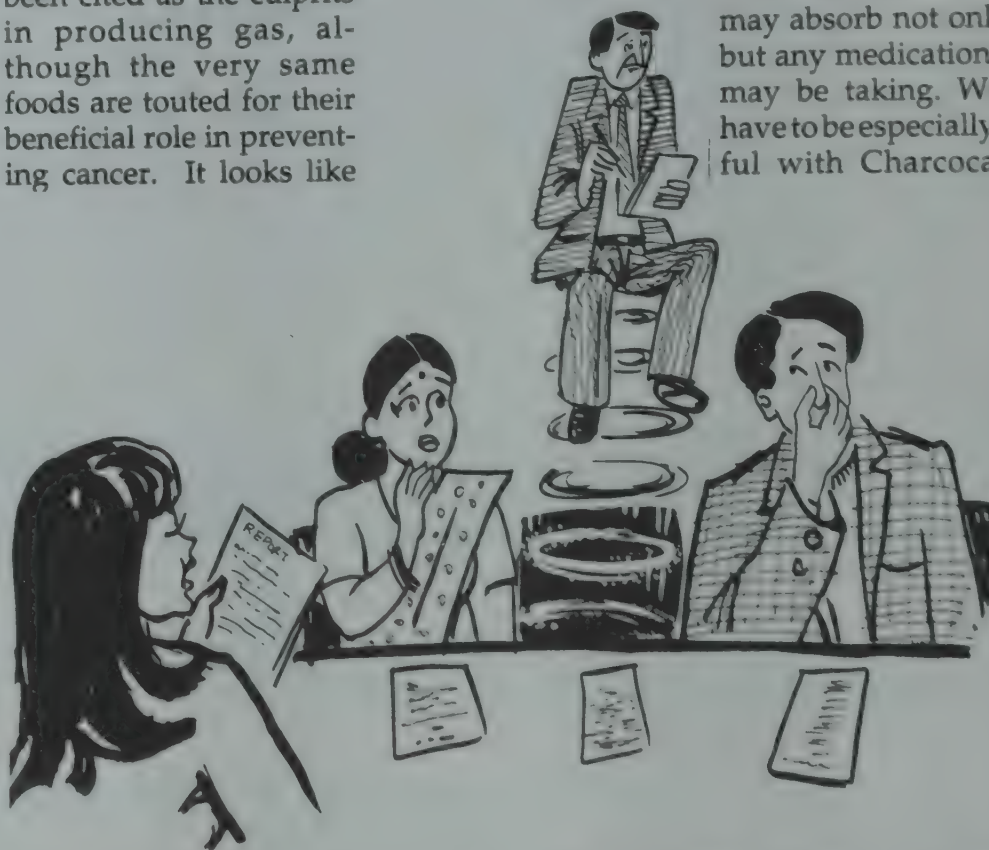
The average person passes gas about 14 times a day. One may succeed in silencing it, but it is hard to bring it into total submission. Physicians refer to it as flatulence. Just as the body finds it necessary to eliminate solid and liquid waste products, it is also forced to expel gas, one way or another. If the gas escapes from the mouth, we call it belching. If infants belch, it is burping. In some societies, belching after a meal is taken by the host as a compliment. In western societies, the escape of gas from either end of the alimentary canal is considered something of a *faux pas*. Technically, though, there is a slight difference between the gas coming out from both these ends. In a belch after a meal, we expel air swallowed while eating. If a sour aftertaste in the mouth follows a belch, it is a symptom of indigestion and it also means we are expelling gases formed in the stomach.

Gas is always formed internally as a result of incomplete digestion. Food must be broken down into simple sugars and amino acids in order to be efficiently absorbed by the body. Complex sugars found in certain foods, however, resist this breakdown process, perhaps because the enzyme that does this work is either weak or the person does not produce this enzyme. These complex sugars pass intact through the stomach and small intestine and enter the large intestine where they settle and begin to ferment. This

fermentation produces carbon dioxide by a process not unlike the one that produces bubbles in champagne.

High-fiber foods such as cabbage, whole-wheat bread, broccoli, and beans have often been cited as the culprits in producing gas, although the very same foods are touted for their beneficial role in preventing cancer. It looks like

culprit. Improved bowel habits may also help. Some people find that taking CharcoCaps, which are charcoal capsules, is useful because charcoal helps in absorbing gases. They are taken at the end of a meal. However, they may absorb not only gas but any medications you may be taking. Women have to be especially careful with CharcoCaps if



the choice is between flatulence and cancer! Remember that not all foods produce gas in all people, except, of course, the champion—beans! Gaseous distention can also be caused by lactose intolerance; people who lack the enzyme called lactase, which breaks down the complex milk sugar lactose, often find themselves passing large amounts of gas after drinking milk. Among others, greasy fried foods, and pulses have received their share of blame. In Andhra Pradesh, a spicy powder made from lightly fried *toor dal* carries the picturesque nickname, *Gunpowder*. If gas and gaseous distention continues to give a problem, then it is a good idea to try an elimination process to identify the

they are taking birth-control pills.

Flatulence is rarely a symptom to worry about and rarely needs the attention of a doctor. It is simply an unavoidable human condition. I remember a childhood story where the personifications of this "ghastly gas", which we shall call here the Silent Killer, and a beautiful Jasmine Bud competed for the favour of a mighty king. The vanity of the king prompted him to favor Jasmine. Needless to say that Silent Killer was furious. And the king had chronic constipation and the rest of the story is well known until the king came down to his knees.

Dr. Vemuri is a professor at Department of Applied Sciences, University of California, P.O. Box 80B, L-794, Livermore CA 94550

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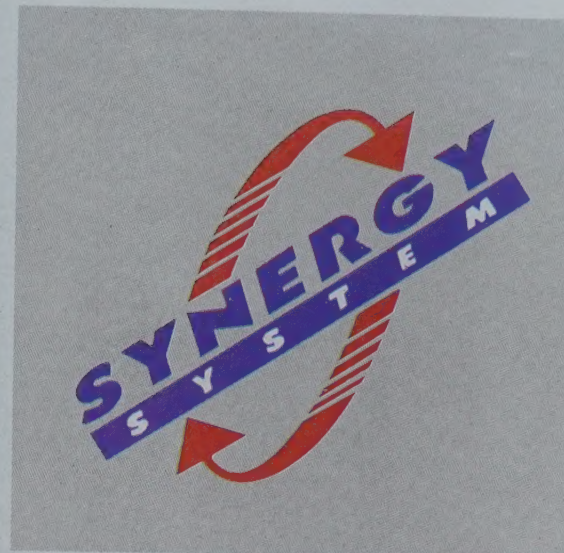
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